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POWER

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Public vs. Private Ownership

SECRETARY HOOVER, in a radio address delivered on Monday evening of last week, made an excellent presentation of the case for private as against public ownership.

After all, it is not so much a question of ownership as of efficient operation and allowable profits.

Is the purchaser of power more likely to get satisfactory service at a reasonable rate from a bureau or department subject to the influences and exigencies of shifting political control than from an organization conducted upon strictly engineering and business principles, with the avowed purpose of making a profit but so effectually controlled that it can collect from the consumer only a fair return upon the capital actually invested?

Are we as likely to get the best service at the lowest cost through governmental investment in and administration of public utilities as by so perfecting and fortifying our system of public service commissions that they shall really hold a brief for the public, and insure it against exploitation through stock manipulation, unnecessary expenditure, surreptitous inclusion of profits and excessive returns?

F. R. Low

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New Byllesby Plant Near Muskogee

EXTENSIVE system covering much of the State of Oklahoma supplied by two new turbine stations at Muskogee and Harrah. Former plant, equipped to burn coal or oil, has complete system for clarifying and softening the muddy river water and is designed to safeguard operation from fluctuations of forty feet in the river level.

TO MEET the growing industrial demands of Oklahoma and the power requirements of the oil fields, an extensive program of new-plant and transmission-line construction by the Byllesby Engineering and Management Corporation for its subsidiary, the Oklahoma Gas & Electric Co., is now nearing completion. The general transmission system, operating at 63,000 volts, covers the central portion of the state and continues to Ft. Smith, Ark., taking in Muskogee, Sapulpa, Drumright, Enid, El Reno, Oklahoma City, Shawnee and a large number of smaller towns, and serving in all 77 communities with a total estimated population of 369,000. It will replace a large number of small reciprocating-engine plants serving their respective communities, which, for the most part, were becoming obsolete and inefficient.

System Supplied by Two Similar Turbine Plants

Two modern turbine plants located centrally will feed the system. They will give more reliable and efficient service than the collection of older plants, and as they are designed for extension as the occasion warrants, the problem of expansion is simplified. One of these plants, having an initial capacity of 22,500 kw. in two units, has been operating for some months. It is four miles from Muskogee on the Arkansas River. The other plant is near Harrah, twenty-three miles east of Oklahoma City and the initial installation, consisting of one 15,000-kw. turbo-generator, in a building designed for two units, with its complement of four boilers, has just about been completed. In layout and general design the two plants are much the same, differing only in minor details, so what is said in the following on the Riverbank Plant near Muskogee will apply in a general way to the Harrah Station. It is the plan to operate the two new stations to the fullest extent, calling upon some of the smaller plants that have been retained only for emergency or peak-load service.

One of the factors influencing the design of the Muskogee plant was a rise and fall in the river level of 40 ft. This made it necessary to set the plant high up in the air, the boiler room in particular, to provide for ash removal above the high-water level. Thus the basement of the boiler room is on a level with the turbine-room floor, and below the latter the vertical condensers serving the turbines and the condenser auxiliaries and service pumps are located in a well some fifty feet deep below the turbine base. Below this well are the intake and discharge tunnels from the river and a long rectangular sump for collecting the pure water drains of the station. Other features are special coal handling, steam piping that has interesting points and a complete water system of unusual flexibility, with river, clarified or softened water available according to the service.

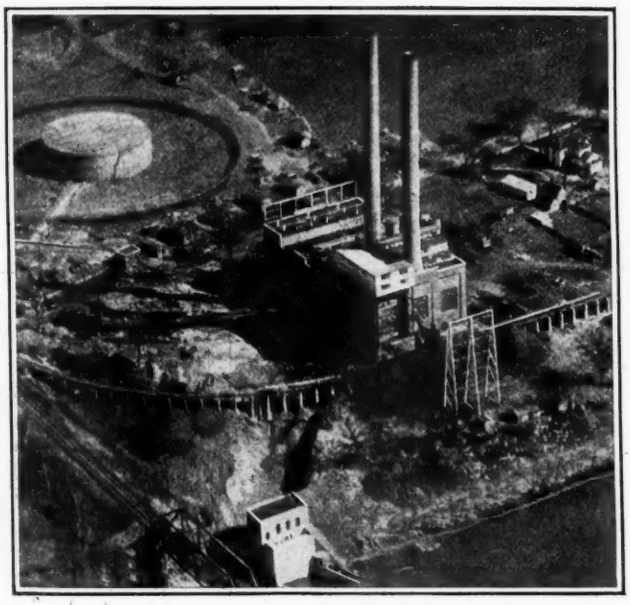


Fig. 1—Airplane view of Riverbank plant, one of the oil tanks in background

Boiler-Room Equipment

In the boiler room there are six water-tube boilers each containing 10,217 sq.ft. of steam-making surface, arranged three on either side of a central firing aisle. They are set singly with insulated steel casings and are vertically baffled for three passes with the usual reduction in area as the gases pass toward the outlet. Each row of three boilers has a self-supporting steel stack centrally located on the building steel. For a distance of 50 ft. above the boilers the stacks are lined with firebrick and for the remainder of their height with concrete. The working pressure is 240 lb. gage and the superheat 250 deg. F., giving a final steam temperature approximating 650 deg. It is the plan to operate the boilers at the most efficient point, ranging from 175 to 200 per cent of rating, but there is stoker and fan capacity to increase this rate of operation on peak loads by 50 per cent. The superheaters are of the convection type, located above the first and second passes. With both oil and coal available in the state provision was made to burn either fuel, with a minimum effort to make the exchange of equipment.

Underfeed stokers with 9 retorts per boiler have been installed. Local coals, such as Sans Bois, Henryetta or McAlester, with the B.t.u. content ranging from 12,000 to 13,700 and ash from 11 to 14 per cent, are now being burned. The fuel requirement in the stoker guarantee for the maximum rating of 300 per cent is 10,330 lb. of coal per hour. With a furnace volume of 2,500 cu.ft. a minimum provision of ½ cu.ft. per pound of coal burned has been made. The stokers are equipped with steam-operated dumps and are driven

individually by induction motors of multi-speed design, the speed variation being obtained by a manually operated, drum-type controller changing the number of poles in the stator. Each motor with its controller is mounted on the boiler-room floor in front of its respective stoker.

For oil burning each boiler will have six burners of a type requiring a round hole in the brickwork of the front wall. These holes have been provided and closed with firebrick plugs, and provision has been made for quickly attaching a false steel front extending from a point just below the bottom of the tube header to the top of the stoker ram casings. This is made possible by the removal of the stoker hoppers. In the space between the false and true fronts of the furnace, air is carried to the burners, admission being at either end of the space from the forced-draft duct serving the boiler. In this way the same fan supplies air for either coal or oil burning. In the furnace the stoker tuyeres are covered with cinders and a layer of firebrick. These changes can be made in a comparatively short time, so that it is an easy matter to change from one fuel to the other to take advantage of the cheaper fuel as the relative prices fluctuate. Dampers in the ducts from the fan discharge control the forced draft to the furnace, and large dampers above the burners can be opened when it is desired to operate on natural draft during light-load periods.

Fuel Oil Circulation

As is usual with the type of equipment installed at the plant, the fuel oil is maintained in constant circulation, passing through the burners and back to the suction of the pump, the control valve for each burner being on the return side. A single valve controls the oil flowing to the six burners of a boiler and a valve in the supply line controls the flow to all boilers on one side of the firing aisle. In operation it will be the plan to set the valves at the burners and headers and bring the boilers up and down together by manipulating the single valve in the supply line. This method greatly simplifies operation and in oil burning is quite feasible.

Duplicate oil pumps and heaters have been installed, and for oil storage two 55,000-bbl. tanks with steam heating and quenching lines have been located some distance from the station, as indicated in the airplane view, Fig. 1. A pumphouse is provided near-by to pump the oil from the tank cars to the storage tanks and from the tanks to the plant.

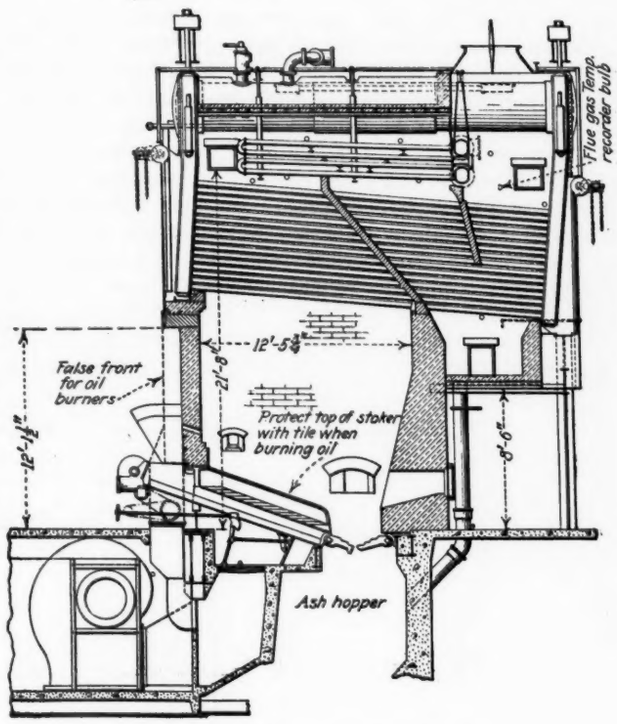


Fig. 3—Section through boiler

Forced draft is supplied by full-housing, double-inlet fans, one per boiler, directly connected to slip-ring induction motors or steam turbines, the number of each being four and two, respectively, in the order named.

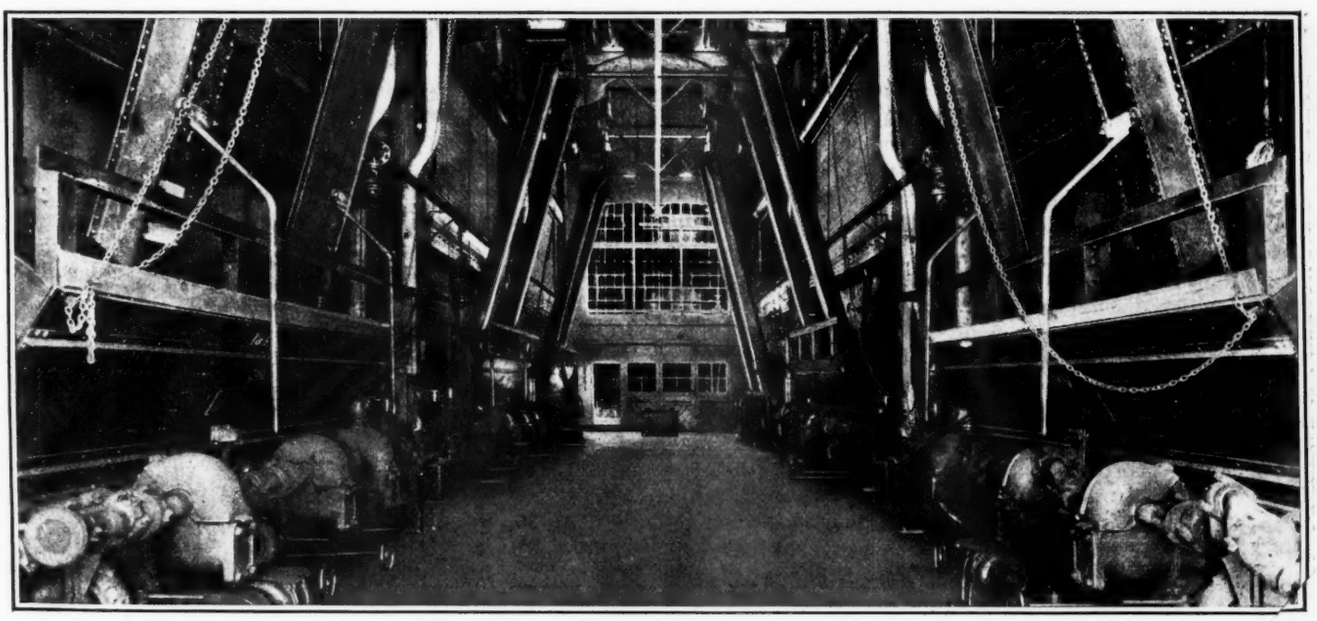


Fig. 2—Central firing aisle in boiler room

The motors have drum controllers at the boiler control panel on the main floor, with the grid resistances in the basement near the motors. The fan turbines also may be manipulated by hand from the control board through handwheels having mechanical interconnection with the throttles. These arrangements for the control of the fuel and the air supply have been preferred to automatic regulation. Normally, each fan supplies its individual boiler, but on either side the ducts are cross-connected so that operation on the common-duct plan may be carried out if desired.

Coal is brought in at grade level by rail, weighed on a track scale and unloaded exterior to the boiler room either into a track hopper or into outdoor storage. Two tracks on a trestle with a locomotive crane to unload and reclaim are the storage facilities, the capacity at present approximating 15,000 tons. A steam-operated automatic dump car is used in reclaiming the coal, delivery being made to the track hopper previously mentioned. From the track hopper a reciprocating feeder delivers the coal through a 75-ton crusher or through a bypass to a pivoted bucket carrier which discharges onto a cross-belt conveyor at one end of the boiler room. Over the end of this belt conveyor the coal is carried into a hopper with a flop gate arranged so that delivery can be made directly into the near end of the overhead bunker on one side of the firing aisle, onto a longitudinal belt conveyor running the length of the firing aisle or onto a second cross conveyor which discharges into the near end of the bunker on the other side of the firing aisle or onto the longitudinal belt serving this bunker. Automatic trippers on the longitudinal belts distribute the coal over the length of the bunkers.

It will be seen that space has been provided between the bunkers through which light is admitted into the boiler room from a monitor above this section of the plant. The capacity of the initial end of the system is 70 tons per hour and of the belt conveyors 75 tons per hour. The overhead bunkers have capacity to store 90 tons per boiler. From them delivery is made through swinging spouts, two per stoker, equipped with gate valves, chain operated from the boiler-room floor. The component parts of the coal-handling system are motor driven throughout with the control at the motor in each case. Revolution counters on the stoker ram shafts check the daily coal consumption.

Brick-lined concrete hoppers of large storage capacity receive the ash from the stokers. Through sliding gates, hand operated by chains and gears, the ashes are dumped into industrial cars. As the ash floor is at grade level, the cars are pushed out by hand onto the premises over a trestle and the ashes used for filling purposes, for which there will be need for years to come.

Although the plant draws its raw water from the Arkansas River, the supply really comes from the Grand River, which enters the Arkansas a short distance above the plant, the flow coming down that side of the Arkansas on which the station is situated. Although somewhat clearer than the water of the Arkansas River, the supply is muddy, containing quantities of suspended matter and from 25 to 30 grains of scale-forming salts to the gallon. For boiler use it was found desirable to clarify the water in sand filters and remove the hardness by Permutit softening.

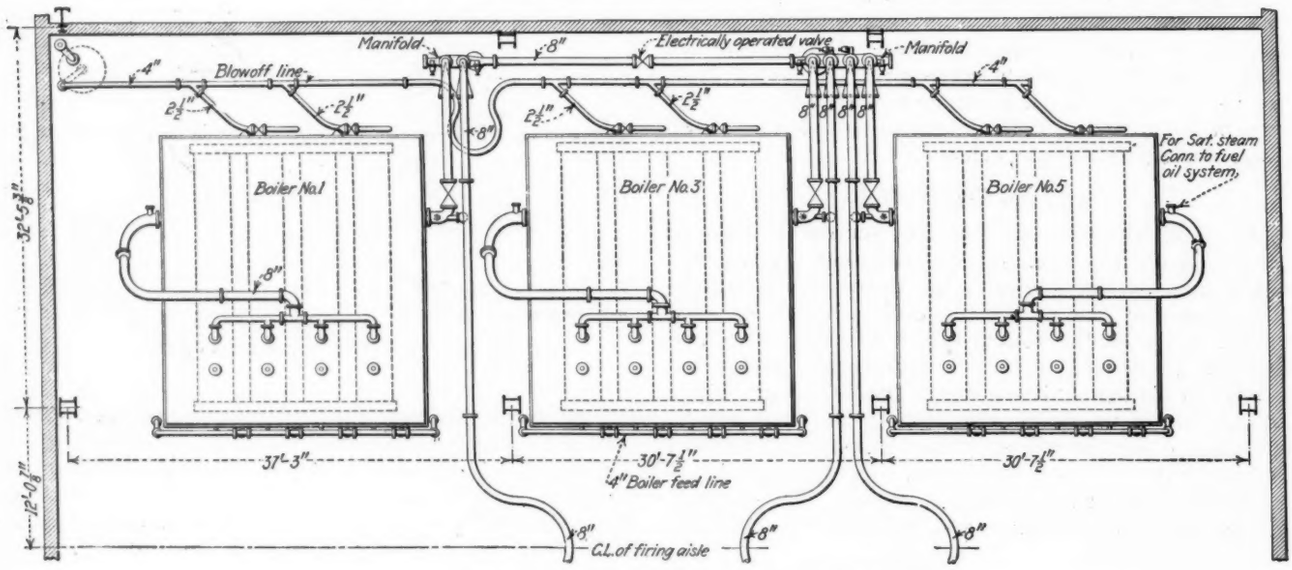


Fig. 4—Plan of one-half of boiler room, showing piping

A complete diagram of the water system is shown in Fig. 7. It will be seen that service pumps draw from the condenser intake tunnel to maintain a supply in the muddy water header. Connections from this header are taken for sprinkling the ashpits and the coal bunkers, and interconnection is made with the cooling-water header serving the oil coolers and, if need be, the air washers for the generators. Air-washer pumps are provided for normal operation with provision for recirculation or for waste to the condenser discharge tunnel.

Makeup water for the boilers passes from the muddy-water header through the sand filters, then through the softeners and to the open feed-water heater under float control or directly to the suction of the feed-water pumps. Storage tanks for clarified water and softened water have been provided to equalize the supply and to pass over short intervals of non-operation of the purifying equipment. These tanks are overhead, and the piping has been equipped with check valves so that

the up-and-down flow to and from the tanks may pass through the same lines. The arrangement will be apparent from the diagram.

Clean drains, such as the heater overflow and drips from the high-pressure piping, are collected in a hotwell reservoir built over the intake tunnel. By a sump pump this pure water is returned to the system through the heater as indicated in the diagram. The dirty and oily drains are collected in sumps at various locations and delivered to the discharge tunnel to be carried away in the river water.

Condensation from the two condensers is delivered by turbine-driven hotwell pumps to a common header and then to the feed-water heater or through a bypass and weir-type meter directly to the suction of the boiler-feed pumps, of which there are two of the four-stage double-suction type driven at 2,670 r.p.m. by 200-hp. steam turbines. These pumps deliver into a main or an auxiliary header, so that each boiler has duplicate feed connections, with automatic regulation on the lines from the main header and hand regulation on the others. Excess pressure governors control the pumps.

To maintain the temperature of the feed water at approximately 210 deg. F., a careful division has been made between motor and steam-turbine drive for the condenser auxiliaries and the various pumps. This, in combination with dual-drive exciters, gives the flexibility in the exhaust steam supply that is desirable to maintain the heat balance under varying operating conditions.

All high-pressure piping in the plant is of steel with steel valves and fittings, Cranelap joints and metal gaskets. The usual header system has been discarded in favor of steel manifolds just long enough to receive the various connections. The leads from four boilers, two on either side of the firing aisle, enter the top of one of these manifolds. From the bottom of the manifold the supply line to the larger turbine unit is taken off and also a header connection supplying the steam-using auxiliaries in the plant. A second manifold receives the steam from the two remaining boilers in the plant and is provided with blank connections for two more boilers that will be installed when the plant is extended. A return bend joins these manifolds, with a sectionalizing valve at the center, so that the boiler groups may be used separately or in unison to supply the turbines. The general arrangement of this piping is shown in the plan view of the boiler room, Fig. 4. This drawing also shows the blowoff piping and the provisions made to care for expansion in both systems of piping.

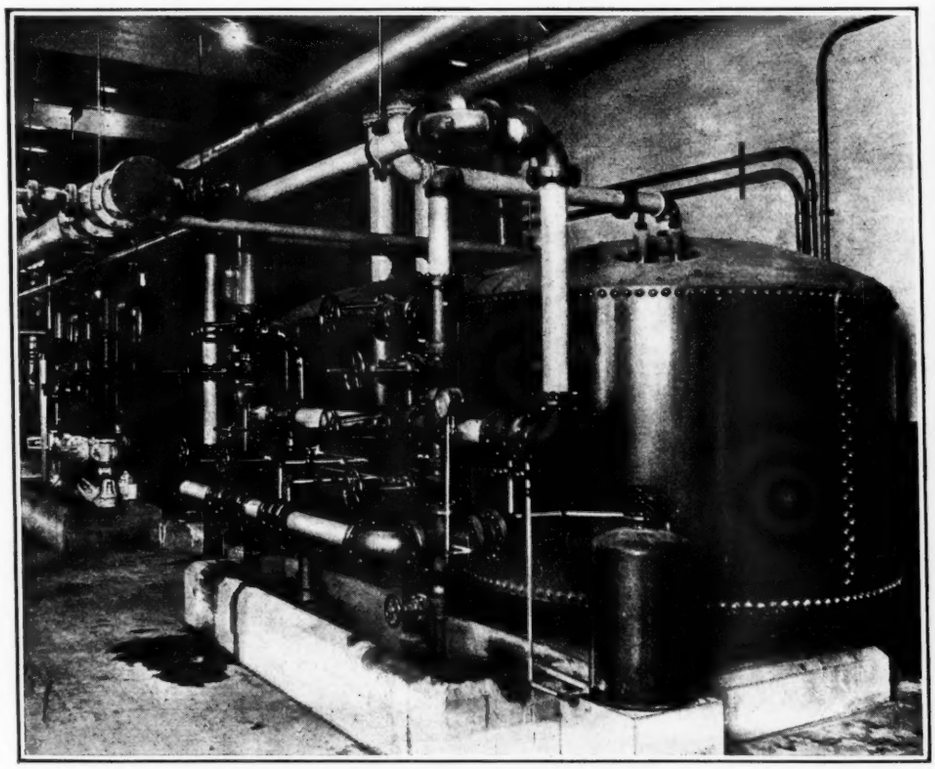


Fig. 5—Water-softening installation

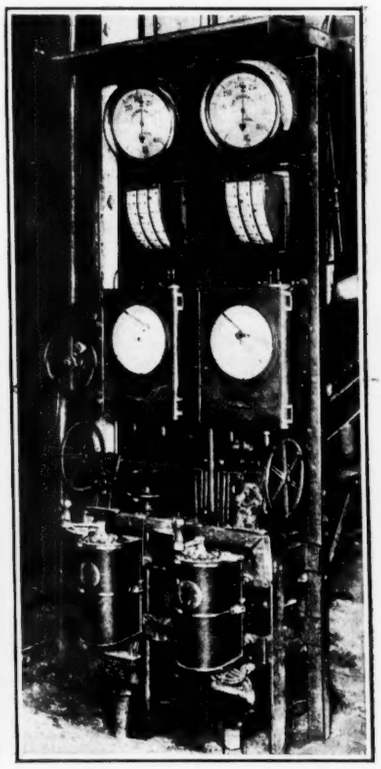


Fig. 6—Boiler control panel

To provide the data necessary for efficient operation, it will be recalled that the incoming coal is weighed on track scales and the individual quantities of coal to each boiler checked by counters on the stoker ram shafts. The feed water is measured in a V-notch recording meter, and between units at the boiler fronts are control boards serving the boiler on either side. On these control panels are boiler meters combining steam flow, air flow and uptake temperatures; five-pointer gages giving the pressure over the fire, at the uptake, the pressure under the tuyeres, at the lower ends of the tuyeres and at the dump grates. Here also are the fan and stoker motor controls consisting of hand-operated drum-type controllers, manually operated controls for the uptake dampers and steam pressure gages for each boiler.

In the present installation there are two main gen-

erating units, one rated at 7,500 kw. and the other at 15,000 kw. Both are turbine driven at a speed of 1,800 r.p.m., the steam conditions at the throttle being 225 lb. gage and the superheat 250 deg. F. The generators deliver three-phase 60-cycle currents at 13,200 volts. Each machine has an air washer arranged for the closed system of ventilation, but provided with hydraulically operated dampers to open the system should the water supply fail.

The condensers are of the two-pass vertical design placed in a well under the turbine-room floor in order to reduce the suction lift on the pumps. It will be recalled that the plant design had to care for a 40-ft. rise and fall in the river level. These condensers contain 23,000 and 13,000 sq.ft. of surface respectively. They are equipped with Phillips washers that will clean

Just below the bottom of the well are the intake and discharge tunnels, both of which have been laid in the same trench, but separating at a point near the screen-house. The intake is provided with the usual trash racks and two traveling screens with space for a third unit. The screens are 8 ft. wide with a height between centers of 52 ft. 6 in.

With the exception of the high-tension transformers and the lightning arresters the electrical equipment is inside in a gallery running along the turbine room. Current is generated at 13,200 volts and is delivered at this voltage to the bus system in the electrical gallery, located at the turbine-room floor level. To insure continuous operation, a three-bus arrangement has been provided, consisting of main, auxiliary and transfer buses. Normally, the feeders draw from either the

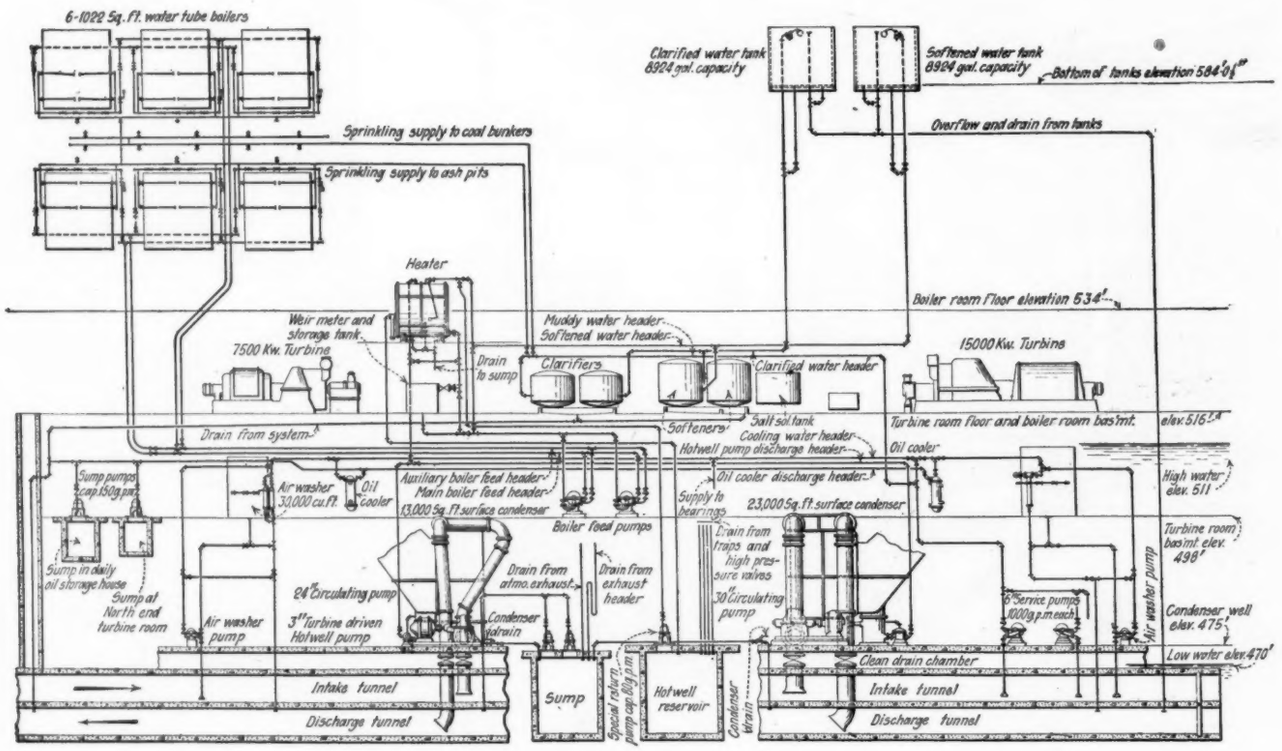


Fig. 7—Diagram of plant water system

the surface while the unit is in operation. Each condenser rests on a concrete foundation and from the side inlet is joined to the turbine by a special cast-iron fitting with a special rubber expansion joint, hydraulically sealed, between the fitting and the turbine. The circulating, hotwell and service pumps are at the bottom of the well, while the boiler-feed, dry vacuum and the oil pumps are on a floor 18 ft. below the turbine-operating level. An automatic elevator under push-button control provides transportation from the heater platform level, which is above the turbine-room floor, to the bottom of the well.

One circulating pump has been provided per condenser. This is driven by a constant-speed motor, so that the variation of the quantity of water with the temperature and the load is obtained by throttling the pump discharge. Of the other auxiliaries the air pump is of the rotative dry-vacuum type, driven by motor and chain, while the condensate pumps are turbine driven.

main or auxiliary bus, but if an oil switch is down for repair or inspection, the corresponding feeder is served from the transfer bus through a special transfer switch coupling the transfer bus to either the main or the auxiliary bus, as may be desired. This one transfer switch does away with duplication of oil switches for each feeder circuit.

The main bus is made up of structural-steel framework with precast concrete barriers between phases. The auxiliary bus is mounted on pipe framework suspended from the ceiling, with the barriers eliminated, while the transfer bus is of similar construction but suspended from the ceiling of the floor above. The 13,200-volt oil switches are on the same floor, while the bench and control boards are in the compartment of the electrical gallery off the turbine-room floor. The control room is inclosed by a plate-glass front, which excludes noise, steam vapor, dust, etc., that might affect the instruments and at the same time gives the operator

a view of the turbine room. The benchboard is arranged in three sections, two for the main generators and a section for exciter control. The main vertical control board is a single 10-panel structure of black marine slate with the usual complement of instruments and the watt-hour meters mounted on sub-bases at the rear. In addition, the control room contains a temperature indicating panel with instruments to indicate and record temperatures at various points in the generator windings and the intake and discharge temperatures of the air for generator cooling. Near this temperature panel are the voltage regulators for the two machines with space for expansion. These regulators operate directly on the generator field rheostats, so that the exciter bus voltage may remain constant.

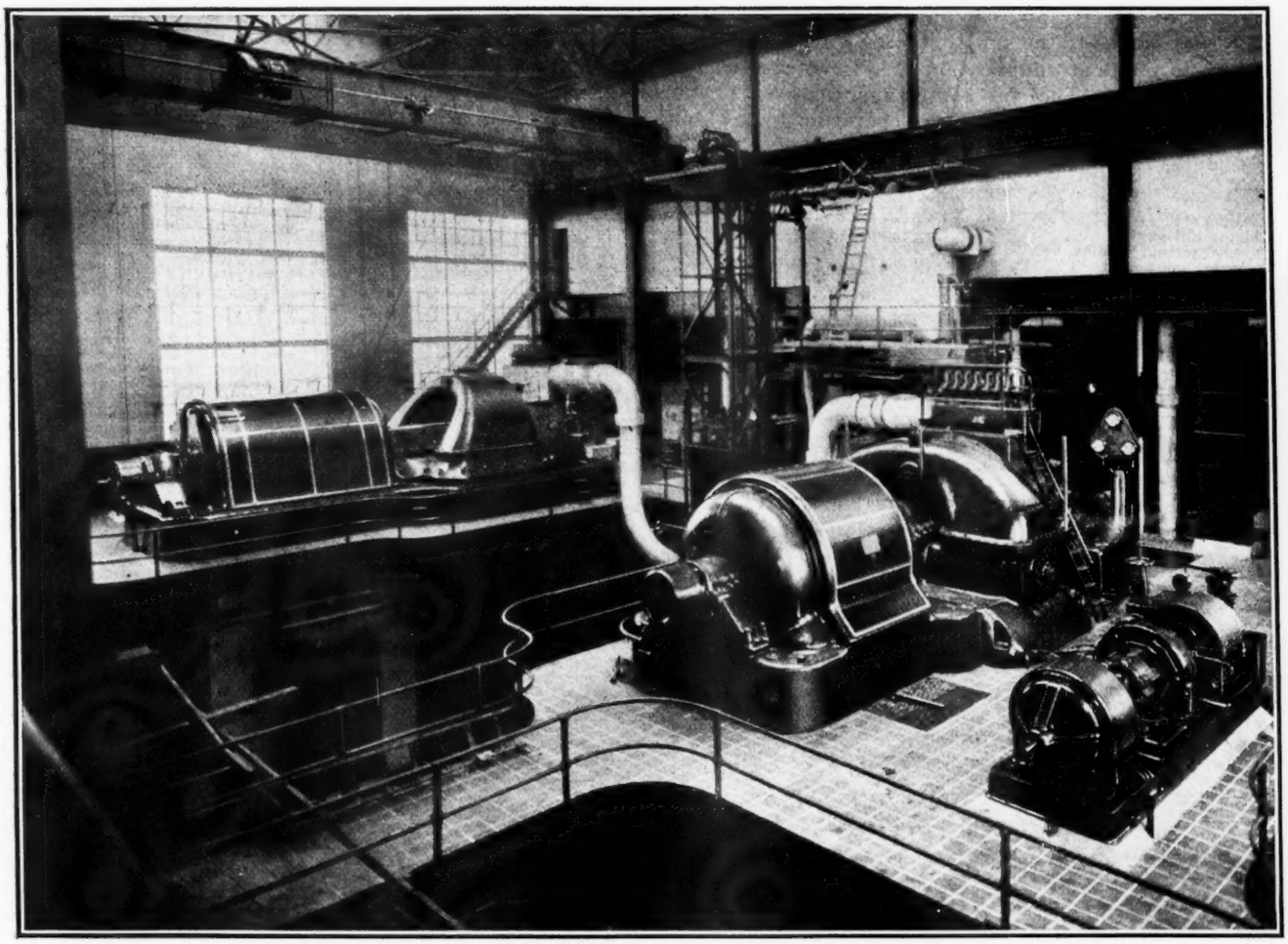


Fig. 8—View in turbine room, showing the two main units

To facilitate operation, the plant is equipped with an intercommunicating telephone system, the usual load indicator in the boiler room and a turbine-room signal system for starting and stopping the main units. To take care of unusual instructions, the signal system is supplemented by telephone communication entirely independent of the main intercommunicating system.

Three feeder lines, two to Muskogee and one to Ft. Gibson, four and ten miles distant, respectively, leave the station at generator voltage. Through transformers connected delta-Y, other service is stepped up to 63,000 volts and delivered to the long-distance transmission system. The 63,000-volt buses are in the upper portion of the electrical gallery. Main and auxiliary buses are in use and so sectionalized that it is possible to get at any portion of either bus for cleaning or repairs without interruption to service. The construction here is standard, consisting of copper-tube buses suspended from the roof of the gallery by porcelain supports. In the high-tension room is the switching equipment and the instrument transformers for the high-tension work. Outgoing lines come out at the side of the station, rise and cross over the plant to the towers carrying the lines across the river.

Through two groups of transformers, with two transformers to the group connected open-delta, but with space for a third transformer when the station expands, station auxiliary power is drawn from the main bus system. These transformers step down from 13,200 to 2,300 volts, with taps brought out for 1,840, 1,495 and 1,150 volts. The station auxiliary bus system, consisting of main, starting and transfer buses, and the transformers, is on the basement floor of the electrical gallery. All motors of 40 hp. and above, operating at 2,300 volts, are fed from the main bus or, in the event of an oil-switch failure, draw their supply from the transfer bus. The motors in the plant are of the induction type of wound-rotor or squirrel-cage design. The former have single oil switches connecting with the

main auxiliary bus, the starting feature being taken care of by cutting in and out the resistance used for speed control. This arrangement does away with starting compensators. The squirrel-cage motors are provided with starting and running oil switches, the former connected to the starting bus which operates at a lower voltage and the latter to the running bus, the two switches being electrically interlocked to insure proper sequence of operation. To take care of an emergency in case the pair of switches serving a particular motor are down, the machine can be switched to the transfer bus and operated in the usual manner through the pair of starting and running oil switches connecting the transfer bus to the supply, these switches serving as before to eliminate duplication of oil switches on each motor circuit. The foregoing applies to 2,300-volt motors. For the smaller motors operating at low voltage, energy from the main 2,300-volt or transfer bus is stepped down to the service requirements.

To supply 250-volt direct-current excitation, two dual-drive units have been provided. Each exciter, rated at 150 kw. and driven by a 225-hp. 2,300-volt induction motor or by a turbine, has sufficient capacity to meet the station needs. The machines are arranged so that if the steam end goes down, the motor automatically picks up the load and vice versa. There is no other reserve for excitation, but with duplicate units, dual drives and an outside source of power there is little danger of failure of excitation current.

The plant was designed and installed by Byllesby engineers, H. Boyd Brydon being responsible for the mechanical end and A. H. Tracy for the electrical work. George F. Phythian was in charge of the installation. F. H. Lane is manager of engineering and construction.

PRINCIPAL EQUIPMENT OF RIVERBANK STATION

GENERAL

Location of plant	Arkansas River near Muskogee, Okla.
Character of service	Light and power
Capacity present building, kw.	22,500
Boiler-room dimensions, ft.	85x101
Distance boiler-room floor to basement floor, ft.	18
Height from boiler-room floor to roof trusses, ft.	43
Width of firing aisle, ft.	21
Width of passage behind boilers, ft.	6
Ratio boiler-heating surface to floor area	7.14 to 1
Turbine-room dimensions, ft.	63x101
Ratio kilowatt rating to floor area	3.53 to 1
Distance basement floor to turbine-room floor, ft.	18
Height turbine-room floor to roof trusses ft.	39
Electrical gallery dimensions, ft.	26x101

BOILERS AND SUPERHEATERS

Manufacturer	Edge Moor Iron Co.
Number of boilers	6
Type	Horizontal water tube, vert. baffled 3 passes
Steam drums, four, outside diam., in.	35
Tubes	440 No. 9 gage, 21 ft. long
Steam-making surface, sq.ft.	10,217
Working pressure, lb. gage	240
Superheat, deg. F.	250
Steam temperature, deg. F.	653
Superheaters (Foster)	Power Specialty Co.
Type	Single loop convection
Surface, sq.ft.	3,840

STOKERS

Manufacturer	Westinghouse Electric & Mfg. Co.
Type	Underfeed, 9 retorts
Drive, induction motor, multi-speed, hp.	12
Control	Manual, drum-type controller

FORCED-DRAFT FANS

Manufacturer	Green Fuel Economizer Co.
Number installed	6
Type	Full housing, double inlet
Capacity, cu.ft. per min.	44,800
Speed, r.p.m.	1,160
Drive	Two turbines and four induction motors
Turbine, 75-hp.	Westinghouse Elec. & Mfg. Co.
Motor, 75-hp.	Westinghouse Elec. & Mfg. Co.

STACK

Type	Self-supporting steel
Diameter at top, inside concrete lining, ft.	13½
Height above boiler-room floor, ft.	250

BOILER-FEED PUMPS

Manufacturer	Worthington Pump & Mach. Corp.
Number	2
Type	Four-stage, double suction
Capacity, gal. per min.	600
Drive	200-hp. Terry turbine
Speed, r.p.m.	2,670

FEED-WATER HEATER AND METER

Manufacturer	Worthington Pump & Mach. Corp.
Type	Two-section, horizontal, open
Number	1
Capacity, lb. per hour	270,000
Water meter, one	Bailey Meter Co.
Type	V-notch recording
Capacity, lb. per hour	400,000

SERVICE PUMPS

Manufacturer	Worthington Pump & Mach. Corp.
Number and type	Two 2-stage centrifugal
Capacity, gal. per min.	1,000
Drive	One 85-hp. Terry turbine, one 100-hp. G. E. induction motor
Speed, r.p.m.	1,920

WATER-PURIFYING SYSTEM

Manufacturer	Permutit Co.
Equipment	Two clarifying sand filters, two softeners and one salt-solution tank
Capacity, gal. per hour	3,900

FUEL-OIL BURNING EQUIPMENT

Manufacturer	Peabody Eng. Corp.
Steam generating capacity, lb. per hr.	480,000
Burners per boiler	6
Equipment	Two Quimby turbine-driven fuel oil pumps, one Blake-Knowles vacuum pump, two Worthington single, horizontal piston pumps, two Griscom-Russell fuel-oil heaters, two 55,000-bbl. oil storage tanks and one 26,000 gal. daily oil storage tank.

COAL AND ASH HANDLING

Manufacturer	Jeffrey Mfg. Co.
Plate feeder	27 in. by 7 ft. 4 in., reciprocating plate type
Pivoted bucket carrier	24x24 in.; hor. cent., 33 ft.; vert. cent., 107 ft.; operating speed, 50 ft. per min.; capacity, 70 tons per hour
Crusher, motor driven, capacity in tons per hour	75
Belt conveyors	Robins Conveying Belt Co.
Equipment	Two 24-in. belts, 88-ft. centers; one 24-in. belt, 37-ft. centers; one 24-in. belt, 15-ft. centers; motor drive; speed, 228 ft. per min.; capacity, 75 tons per hour
Ash cars, two, 54 cu.ft.	Sackett Screen & Chute Co.
Coal car, steam-operated dump	Western Wheeled Scraper Co.
Locomotive crane	Link Belt Co.

TURBO-GENERATORS

Manufacturer	General Electric Co.	
Steam pressure at throttle, lb. gage	225	
Superheat at throttle, deg. F.	250	
Generators	Three-phase, 60-cycle, 13,200-volt	
Capacity, kw. at 80 per cent power factor	15,000	7,500
Speed, r.p.m.	1,800	1,800
Air washer, type "V" Spray Eng. Co., cu.ft. per min.	60,000	30,000
Washer pump, gal. per min.	320	165
Pump drive, motor, hp.	15	7
Condensers, two-pass vertical, Worthington, with Phillips exp. Joints, sq.ft.	23,000	13,000
Capacity, lb. steam per hour	180,000	100,000
Circulating pumps, one per condenser	27,000 g.p.m. 22 ft. head	15,000 g.p.m. 22 ft. head
Drive, G. E. 2,300-volt, ind. motors, hp.	250	150
Air pumps, Laidlaw feather valve, motor drive, size, in.	29x18	25x18
Hotwell pumps, two-stage, Terry turbine drive, gal. per min.	450	300
Exciters, dual drive, 220-volt, kw.	150	150
Switchboard	Westinghouse Elec. & Mfg. Co.	
Transformers	Westinghouse Elec. & Mfg. Co.	
Revolving screens, two 8 ft. wide, 52 ft. 6 in. centers	Chain Belt Co.	
Screen wash pumps, 3 in., two-stage	Thomas Pump Co.	
Pump drive, 40 hp., 220-volt motors, 1,720 r.p.m.	General Electric Co.	

MISCELLANEOUS MECHANICAL EQUIPMENT

Traveling crane, 50-ton, 3-motor	Niles-Bement-Pond Co.
Oiling system, filters, continuous by-pass plan	S. F. Bowser & Co., Inc.
Valves and piping	Crane Co.
Stop and check valves	Crane Co.
Blowoff valves	Crane Co.
Firebrick	Missouri Firebrick Co.; Walsh Fire Clay Products Co.
Safety valves, consolidated	Manning, Maxwell & Moore, Inc.
Pipe covering	Smith Totman Co.
Pump governors and feed-water regulators, Copes	Northern Equipment Co.
Steam traps	Armstrong Machine Co.
Railroad track scale, 125 ton	Fairbanks-Morse & Co.
Service elevator, 1,000-lb. capacity	Otis Elevator Co.
Steam-flow meters	Bailey Meter Co.
Draft gages, 5 pointer	Bailey Meter Co.
Pressure gages	Bristol Co.
Recording gages	C. J. Tagliabue Mfg. Co.

Dividing Load Economically Among Turbine-Driven Alternators

By J. DARE McADOO
Test Department, West Penn Power Company

IN AN article on operating hydro-electric units that appeared several months ago in *Power*, the author, in discussing division of load between alternators, said that while not the most efficient method, the more practical one is to operate generators of approximately the same rating at equal loads and power factors. If, however, there is some disparity in the ratings, the generator tending to overheat should be operated by increasing the kilovolt-ampere load on the larger and cooler machines. This lessens the resistance losses on the warmer machine.

Although the method described is probably the most practical and commonly followed, it is hardly to be unconditionally recommended. Of course, as the article states at times of heavy loading the operator who regulates the load must be guided by consideration of the maximum allowable temperature. However, when the load is economically divided, the sum of the generator losses will tend to be a minimum. If all the machine ratings, characteristics and the efficiency of cooling are the same, there will be no appreciable difference in temperature. Here, it will seldom if ever be necessary to depart from the economical method of load division by operating equal loads and power factors in all units.

STATION load is often divided among the units on the basis of relative capacity rather than steam economy. In this interesting study of the subject it is brought out that the cost of power delivered depends on many factors besides that of unit capacity. A synchronous condenser, for instance, should not be loaded to full capacity with wattless current, regardless of reactive current carried by the generators. Further discussion by readers would be welcomed.

In working out a machine loading schedule, the first consideration should be given to the prime movers because it is there that the large losses from improper load division may result. The work of making such a schedule is greatly simplified by using the curves of total steam consumption rather than those of steam consumption per unit of load or water rate. Fig. 1 shows the steam-consumption curves for two turbines by plotting steam per hour to load.

The dotted line is for a larger and more efficient turbine than the one whose curve is represented by the solid line. It will be seen that there is a certain amount of steam consumed at no load to keep the turbine up to speed and that the total steam consumption at any load is equal to this no-load steam consumption, which will be represented by A_1 plus a quantity of steam proportional to the load carried. It has been found that the greater part of the steam-consumption curve thus plotted, of both reciprocating engines and turbines, is sensibly straight and that the steam consumed at any load can be accurately expressed by the general equation,

$$W = A + BL$$

where A is the steam consumption at no load, L is the load in thousands of kilowatts on the engine or turbine, and B is the "slope rate," or the pounds of additional total steam per hour, consumed by the turbine divided by the corresponding additional thousands of kilowatt-hours load. This will be later illustrated by an example. In some turbines there is a change in the value of the slope rate at some loads due to a change in the method of flow of steam through the turbine, such as is caused by the admission of steam through a secondary set of nozzles or in a middle point in the expansion. Circles denote changes in slope rate in Fig. 1. Where there is only one change in method of steam flow such as results from primary and secondary admission valves, the steam consumption curve will consist of two straight lines having different slopes.

The slope of the first part of the curve will be represented by B, and that of the part after the opening of the secondary steam admission valve will be represented by C. The value of C is determined in the same manner as that of B; that is, it is the amount of additional steam that must be admitted to cause a unit increase in the power output in the range of loads above the point of opening of the secondary valve and below the point of opening of the tertiary valve, if there is one. Where there is a tertiary or third valve, the steam-consumption curve will consist of three straight lines of different slopes.

An example of figuring the slope rate is illustrated in Fig. 1. The steam consumption W at 10,000 kw. on No. 2 turbine is 115,000 lb. per hour as the arrows indicate. At 14,000 kw., the point of opening of the secondary valve, it is 157,080 lb. per hour and at 18,000 kw. is 206,880 lb. The increase in total steam between 10,000 and 14,000 kw. is 42,080 lb., and the increase in load is 4,000 kw. Dividing the steam by the load in thousands of kilowatts, 42,080 ÷ 4 gives the value of the slope rate B_2 equal to 10,520 lb.

From 14,000 to 18,000 kw. the increase in load is 4,000 kw. and the steam increase is 206,880 less 157,080, or 49,800 lb. Dividing as before gives a value of C_2 equal to 12,450 lb. Thus the values of slope rates, or rates of increase in the total steam consumption per unit of loading, can be determined for any turbine from the total steam-consumption curve. This curve may be furnished by the turbine manufacturers on request. It can be drawn from the water-rate guarantees or from the water rates determined from actual tests.

When an additional turbine is placed in service, the total steam consumption is immediately increased by the amount of the no-load steam consumption of the turbine started. The steam consumption is additionally increased if the added turbine has a slope rate B greater than any of the other turbines in service. This is because it will be necessary to take part of the load from one of the turbines previously in service at lower steam consumption so as to give some load to the tur-

bine just placed on the line, at a greater water rate. As an example, suppose the turbine referred to as No. 1 in Fig. 1 was being operated at 18,000 kw. load, requiring 189,000 lb. steam per hour. If No. 2 turbine were started and loaded to 5,000 kw., leaving 13,000 kw. on No. 1, the total steam consumption would then be 202,915 lb. per hour as compared with 189,000 when No. 1 turbine was operated alone. The steam consumption has been increased by 13,915 lb., which is equal to the no-load steam consumption of No. 2 turbine plus 5,000 kw. times the difference in the slope rate values of the two turbines.

From these considerations it will be evident that an additional unit should not be placed in service until after all the turbines running have been loaded up to the point of change in slope of the total steam-consumption curve, where the secondary valve begins to open.

When the turbines in a plant have no-load steam consumptions proportional to their respective ratings, they should be placed in service in the order of their slope rate values, the machines having the higher value of B being started last.

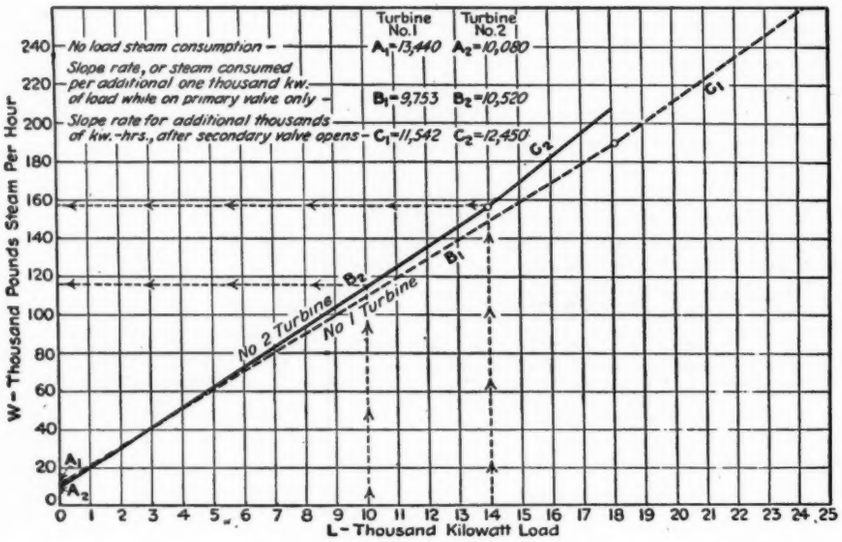

Turbine No.1
Turbine No.2
No load steam consumption — A_1=13,440 A_2=10,080
Slope rate, or steam consumed per additional one thousand kw. of load while on primary valve only — B_1=9,753 B_2=10,520
Slope rate for additional thousands of kw.-hrs., after secondary valve opens — C_1=11,542 C_2=12,450
W - Thousand Pounds Steam Per Hour
L - Thousand Kilowatt Load
No 2 Turbine
No 1 Turbine

Fig. 1—Steam per hour required for load in thousands of kilowatts

No. 1 turbine curve represents a larger unit than No. 2, requiring more no load steam, but less at large loads.

When there is a great difference in the efficiencies of the turbines in a given station, the value of the slope rate C for the range of loads above the point of opening of the secondary valve on the most efficient turbine may be nearly as low or lower than the slope rate B for the least efficient machines. Where this is the case, it will be desirable to raise the load on these most efficient turbines considerably above the point where the secondary valve opens before starting the less-efficient turbine.

When an additional turbine is started, the total steam consumption of the station is increased by the amount of the no-load steam consumption of the added turbine. The load on the most efficient turbine should be increased beyond the point of opening of the secondary valve before the additional machine is placed in service, by an amount determined from the formula,

$$S = \frac{A_2 \times 1000}{(C_1 - B_2)}$$

where A_2 is the no-load consumption of the less efficient turbine, C_1 is the slope of the most efficient steam-turbine consumption above the load at which the secondary valve opens, B_2 is the slope of the first part of the consumption curve of the less efficient turbine, and S is additional load on the secondary valve in kilowatts.

This equation is based on the assumption that the portion of the steam-consumption curve above the point of opening of the secondary valve continues straight. In practice the curve is likely to change in slope near the maximum load. For this reason the foregoing equation should apply only to this straight portion of the line.

As an example, suppose the No. 1 turbine shown in Fig. 1 was being operated and it was desired to know what the load should be allowed to rise to on this turbine before starting the No. 2 turbine, the curves of which are shown in Fig. 1.

The no-load steam consumption of the No. 2 turbine A_2 is 10,080 lb. per hour and the slope rate B_2 is 10,520 lb. per hour per thousand kilowatts. The slope rate C_1 of turbine No. 1 is 11,542 lb. per hour per thousand kilowatts, and the point of opening of the secondary valve is 18,000 kw. Applying the equation, we get

$$S = \frac{10{,}080 \times 1{,}000}{11{,}542 - 10{,}520} = 9{,}860 \text{ kw.}$$

This means that No. 2 turbine should not be started until after No. 1 turbine's load had been increased 9,860 kw. above 18,000 where the secondary valve opens, or to 27,800 kw. total load.

It is probable that before this load is reached some other change in the steam flow will have occurred or that the leaving losses of the turbine will have increased sufficiently to cause the steam-consumption curve to depart from a straight line. Therefore it is not always desirable in practice, for these reasons and because of the necessity of keeping reserve capacity in service to increase the load on No. 1 turbine much above 18,000 kw.

In a plant consisting of a number of different type turbines the problem of determining when to start an additional turbine sometimes becomes quite complicated. However, after it has been decided what turbines are to be operated for any given load, it is easy to determine the most economical load division provided the slope rates of the different turbines are known. The turbines in this case should be loaded in the order of the value of the slope rates; the turbine having the highest slope rates should not be loaded until after all the others have been loaded to the point where their steam-consumption curves change to a slope greater than B of the least efficient turbine in operation. With the two turbines shown in Fig. 1, No. 2 turbine should not be loaded until No. 1 has been loaded to 18,000 kw. After No. 2 has been loaded to 14,000 kw., the point where the slope rate changes, any additional load should be placed on No. 1 turbine.

Fig. 2 shows the effect of unequal loading on two turbo-alternators of the same size and characteristics, including water rates. At high loads the water rate is seen to be considerably increased with unequal loading.

At 40,000 kw., the water rate at balanced load is 11.35 and with 8,000 difference, 11.66 lb. per kilowatt-hour.

With generators the only loss that varies appreciably with the load is the copper loss; that is, the loss caused by the passing of current through the resistance of the generator. The voltage necessary to cause a flow of current through any resistance is proportional to the current and the resistance. When the flow of current through a resistance is increased, the voltage drop across the resistance is also increased in the same ratio as the current increases. The power lost in this resistance as heat is equal to the product of the current flowing and the voltage drop. The voltage drop is proportional to the current, so that the power varies in proportion to the square of the current.

Since with constant voltage the kilowatt-amperes (amperes per phase $\times$ voltage $\times$ 1.732 for a three-phase generator) is proportional to this current, the copper loss may be taken as proportional to the square

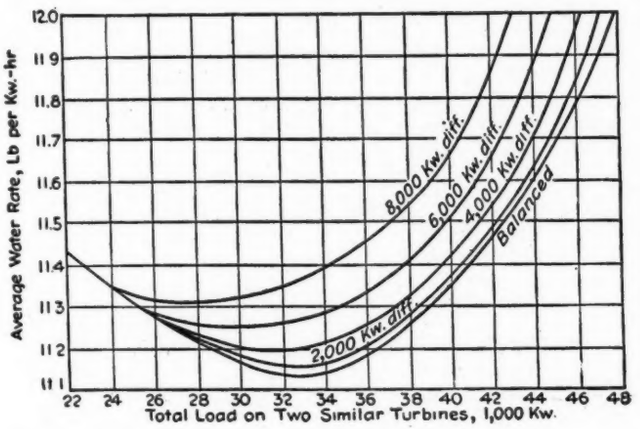


Fig. 2—Water rate with balanced load is less than with unbalanced on similar units

of the total kilovolt-amperes. The square of the kilovolt-amperes is equal to the kilowatts squared, plus the square of the reactive or wattless kva., or $(\text{kva.})^2 = (\text{kw.})^2 + (\text{R.kva.})^2$.

Assuming constant voltages, the copper loss will in a given machine be proportional to $(\text{kva.})^2$ or to $(\text{kw.})^2 + (\text{R.kva.})^2$, in which statement we have called the reactive kva. by the term R.kva.

Through use of the processes of calculus it can be shown that the sum of the losses will be a minimum when the kw. and the R.kva. of the generators are kept at values inversely proportional to the resistance of the generators or synchronous condensers. This means that with synchronous machines of similar characteristics the kw. and R.kva. should be held at values proportional to the generator rating.

Of course the method of dividing the kw. load should be determined from consideration of the characteristics of the turbines rather than from consideration of the generator losses. However, in the case of the R.kva. the generator losses will be the only factor that needs to be considered in determining the most economical method of dividing the wattless current between machines operating on the same bus, since the turbine load is practically unchanged where the kw. load is not altered.

Where the turbines have different efficiencies, it will, as shown before, be desirable to carry low loads on some of the less efficient turbo-generators. In this case the power factor will be lower on the lightly loaded machine when the R.kva. is divided the most economically. An extreme case of unbalanced kw. load occurs when one generator is operated as a condenser. In this case also our rule will apply—that the R.kva. should be maintained on the different synchronous machines feeding to the same bus at values inversely proportional to the resistances of the machines. This operation will result in keeping a relatively low current on the synchronous generator, as it has the same characteristics as the turbine-driven generators. Where generators are tied together on the secondary side of the transformer banks, the transformer resistance should be considered as a part of the generator resistance when determining the loss resulting from improper load division.

Although the saving resulting from improperly dividing the R.kva. between generators will in most cases not be great, it is a saving that can be effected with little effort on the part of anyone. It is necessary to divide the kva. in some manner, and it is no more difficult to do this in the proper manner. Most operators will experience some satisfaction in knowing that they are making the most economical division of the R.kva. even if the saving is so small that it will not be apparent in the plant efficiency as a whole.

While many conditions other than those mentioned may be cited as having a possible effect on the economical load division, such as core loss in relation to dividing wattless current, it is believed that the general principles, as before described, represent a distinctly improved method over that of being guided by machine rated capacities or heating alone, since the prime-mover steam consumption undoubtedly deserves consideration. Actual deductions may be further complicated by units with a larger number of admission valves than those cited. No load losses are increased above those described, by the power required for condenser auxiliaries. Further discussion from a different viewpoint would undoubtedly be of advantage.

Buying Second-Hand Machinery

BY JOHN CASSIDAY

Many times the management of a power plant feels that a decided saving could be made by purchasing used or second-hand machinery, but is deterred by the fear that the element of risk is too great. While there is always a possibility of making an unsatisfactory purchase unless care can be exercised, if proper investigation of the history and condition of the used machine is made the risk becomes minute or totally disappears. Certain parts most subject to wear or highly indicative of the care the machine has had, should be examined. Nothing should be taken for granted, and a broad statement from the vendor that "the machine is in good condition" should not be accepted save when substantiated by a close examination of the machine.

The term "good working condition" is most general, its specific meaning depending entirely upon the mental attitude of the guarantor. The first step to take before purchasing a used engine is to ascertain the make, cylinder, size and serial number. Inquiry of the builder will always result in data as to the machine's age, original purchaser, steam pressure and the r.p.m. for which the engine was designed.

Wear in a steam engine evidences itself in the cylinder. For this reason all cylinders are made with walls

thick enough to permit two or more reborings. In investigating a used engine, the cylinder head should be removed and the walls examined. If the counterbore has disappeared, one is quite safe in assuming that the engine has had a number of reborings.

Since a low r.p.m. engine should run for at least fifteen years before reboring and even a high-speed machine should not need such repairs earlier than eight years, signs of more than one reboring may be taken as proof that the engine has had severe treatment or has been set out of line. Detection of reboring is possible by checking the measurement of the cylinder diameter with the data given by the engine builder. In some engines reboring has been indulged in to such an extent that the counterbore has practically disappeared. Since so much reboring is indicative of either poor machine, excessive abuse with absence of lubrication, or of misalignment, as a rule such used machines prove a source of grief to those who are persuaded to take a chance.

The condition of the piston-rod stuffing box is always an excellent clue to the engine's operating history. If the gland is worn out of round or if the rod bears signs of scoring, it is well to look elsewhere for the purchase. It is not unlikely that a badly scored rod has been turned down smooth, but this will show up at the end where it enters the crosshead. The piston likewise is entitled to scrutiny, for flattened places on its barrel indicate that the piston or cylinder is out of true.

It is usually deemed unnecessary to check the connecting rod for alignment, but since one is going to spend real money, the slight charge made by a machine shop to block and check up the rod is low enough to justify itself. Similarly, the crankshaft should be checked for straightness and for alignment with the crankpin. The bearings are usually in good condition, but should be examined for fractures in the pedestal and babbitt linings.

The valve gear wears more rapidly than any other part. In the case of a Corliss or other rotating gear, if there is much play between valve and seat, new valves and rebored seats should be demanded. As for the governor, this vital part is seldom in bad condition and any defect can be remedied at low cost, but it is well to stipulate in the purchase contract that the vendor will make any correction needed to prevent the machine from racing or showing more than a 10 per cent speed variation from no load to full load.

Buying Second-Hand Boilers

Purchasing of used boilers calls for more investigation than any other machine. The first step the customer should take is to consult the state or municipal boiler rules committee or chief inspector as to state or local requirements. Several states and cities having boiler regulations prohibit the importation and reinstallation of a used boiler regardless of its condition. So stringent are some states that a boiler may not be shipped out of the state for repairs and returned.

Some boiler insurance is carried by most plants. It is worth while to have the insurance company inspect the boiler. This inspection is of twofold benefit—the inspector, after examining the equipment, will render impartial judgment upon which one can depend, and in addition one knows what pressure the insurance company will permit. Of extreme advantage in case of a subsequent explosion is the prior inspection, for it is proof that the purchaser exercised due caution in his purchase.

If for any reason such an authoritative inspection is impossible, one should not fail to give a personal study of the boiler, not being stopped by the newness given to the shell by a fresh coat of asphaltum paint. The interior should be free from scale and the tubes should show little if any pitting. The tube ends of used boilers often are burned to such an extent that the heading is gone. Insist on the replacement of such tubes and likewise the rerolling of any tubes found weeping upon the application of a hydrostatic pressure test of $1\frac{1}{2}$ times the working pressure. Crawl into the shell and strike the crowfoot braces with a hammer; if these are tight, they will emit a sharp ring when struck.

Used Oil Engines Should Be Carefully Examined

In the purchase of used oil engines caution should be shown. Frequently, the engine offered for sale is in a dismantled condition. Under such circumstances the operating behavior of the engine cannot be ascertained. Even though the cylinders, pistons and other parts seem in good shape, the engine may not function properly. It is suggested that the engine be operated under load and afterward the details be examined for wear.

For example, recently a machine broker negotiated the sale of a Diesel engine. He was so confident of the engine's condition from seeing it started up cold and operated for a half hour or so, that he insisted on the purchaser seeing the machine in operation, although the latter was willing to accept the brokers' statement. The machine started smoothly and operated in a satisfactory manner for about one hour, when the safety valves on two of the cylinders began popping. This was at first assumed to be due to the spray-valve needles sticking, which admitted fuel into the cylinder during the compression stroke and so caused preignition. The machine was stopped, new needles put in, and the packing adjusted. The engine, after about three hours' shutdown, was started, ran for two hours and then began to preignite.

A Diesel engineer was called in, the cylinder heads removed, and after some examination he stated that the trouble was traceable to worn pistons. It seemed that when the crankcase oil grew warm, it gassed to some extent. This gas was drawn up along the piston on the suction stroke and of course caused the preignition on the compression stroke. New piston rings stopped the trouble, but the sale was not consummated until the liners were rebored and new pistons provided.

Cylinder heads should be closely examined for signs of fracture and the liners and pistons measured with micrometers. The crankshaft may be sprung, but this will show by pounding during operation. Usually, it is well worth while to engage an expert to examine the machine, for the average engineer is not familiar enough with the oil engine to make his judgment of any value.

Such machines as duplex steam pumps, fans, etc., are simple in construction and defects are easily detected.

There is a class of used machinery of a totally different nature. This includes machines that have been purchased and completely rebuilt. While by no means the same as new equipment just out of the factory, this rebuilding, when done by a reputable firm, puts the engine into the same working condition as when new. The guarantee of the rebuilder is usually sufficiently broad and sound as to justify one in purchasing the machine with the same confidence as he would a new piece of equipment.

Tests for Determining Type of Direct-Current Machines

IT IS shown how to distinguish between the different types of direct-current motors, also between direct-current machines and alternating-current computation-type motors

By B. A. BRIGGS

WITH the many types of motors now in use it is little wonder that the electrician or operating engineer finds himself in doubt at times as to just which type he is dealing with. There was once a time when, if a motor had a commutator, the machine could be put down as being of the direct-current type, but that day has long since passed and commutator-type motors for use on alternating-current systems are becoming quite numerous. Furthermore, there are a considerable number of different classes of this motor for both single-phase and polyphase circuits, and new types are being brought out at frequent intervals.

Fortunately, aside from the name-plate marking, there is a definite difference in the stationary elements of the two classes, which make distinguishing one from the other comparatively simple. All direct-current machines have a field frame with projecting poles, as in Fig. 1, while the field frame, or as it is usually called, the stator of all commutator-type alternating-current motors, has a distributed winding around the inner periphery of a laminated core as in Fig. 2. This should not be confused with the compensating winding *C* used in the pole faces of some direct-current machines, as in Fig. 3. The compensated-type machine, Fig. 3, has projecting main poles *B* with field coils on them, as in Fig. 1, and in addition has a distributed winding in the pole faces. The machine, Fig. 3, also has interpoles *A* between the main poles.

On the name-plate of modern-type motors the necessary information is given to identify correctly the circuit on which they are intended to be used. For example, in addition to the manufacturer's name it will be stated that the machine is direct-current, is varying or constant speed, whether the rating is continuous or intermittent, the voltage, current, speed and if the motor is of the series, shunt or compound type, as in Fig. 4. On the alternating-current types it will be stated that the machine is for alternating current and in addition to giving the horsepower, speed, voltage and current, the number of phases and cycles will be given, Fig. 5. If there were no distinguishing marks other than the phases and cycles on the name-plate, it would at once class the machine as belonging to one of the alternating-current types, since these two terms do not belong in direct-current circuits.

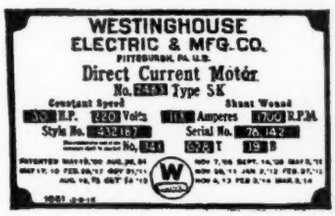


Fig. 4—Above; direct-current motor name-plate

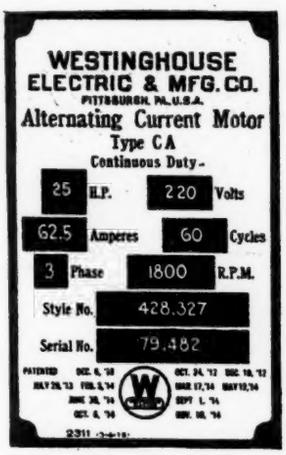


Fig. 5—Right; alternating-current motor name-plate

There are motors of the universal type that can be used on either direct or alternating current, but these are, for the most part, of very small size such as used on domestic appliances. All such motors have an armature and field structure as in a direct-current machine, but the field frame is built up of thin sheets of iron as is the armature core. Such machines generally have it indicated on the name-plate that they are for both direct and alternating current. Outside

Fig. 1—Field frame for four-pole compound interpole-type motor

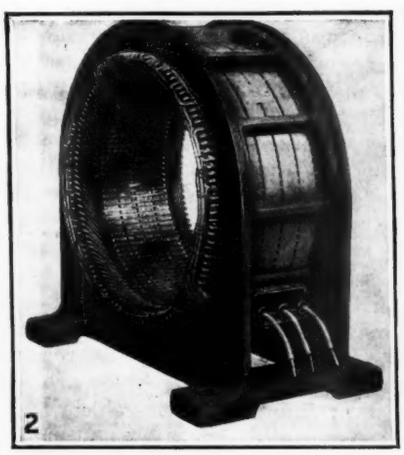


Fig. 2—Stator for three-phase commutator-type variable-speed motor

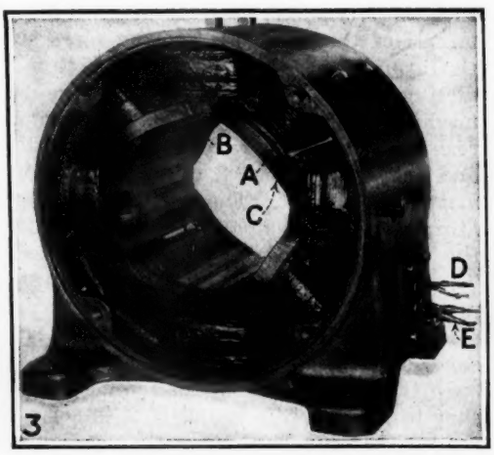


Fig. 3—Field frame for four-pole shunt interpole compensated motor

of these very small-sized machines the universal-type motor has not been used to the author's knowledge except in one railway installation. In this case the motors are of large capacity for use on electric locomotives and operate on alternating current when running on one system and direct current when operating on another company's tracks.

In general there are three classes of direct-current motors—series, shunt and compound. These machines may be of the interpole or non-interpole type. However, so far as the number of external terminals is concerned, the presence of interpoles does not change the number, since the interpoles are connected in series with the armature and one interpole and one armature lead brought to external terminals, as will be subsequently shown. Both the series and the shunt motor will generally have four leads brought to external terminals, as in Figs. 6 and 7 respectively.

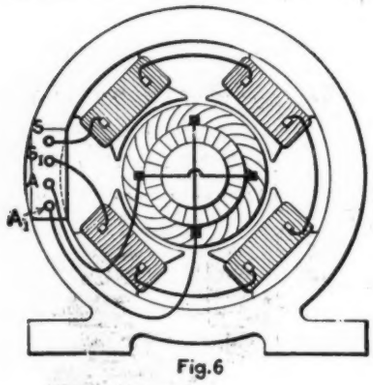


Fig.6

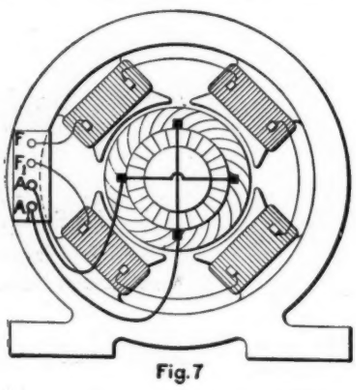


Fig.7

Fig. 6—Series motor; field-coil leads same size as armature leads

Fig. 7—Shunt motor; field-coil leads smaller than armature leads

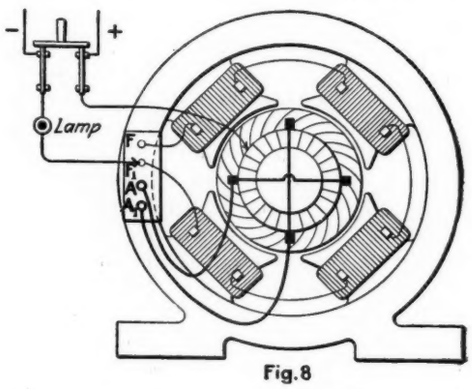


Fig.8

Fig. 8—Testing for field-coil and armature leads

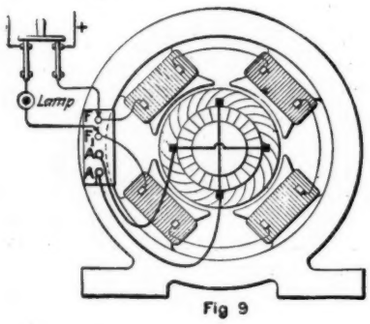


Fig 9

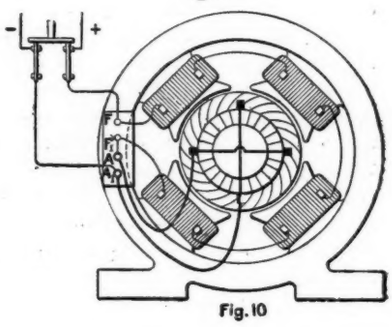


Fig.10

Figs. 9 and 10—Testing to determine type of motor

In the series motor the field coils are connected in series with the armature and therefore must carry the same current. For this reason the leads and terminals of the field coils are the same size as those for the armature, as in Fig. 6, and this is one way of distinguishing this type of machine. On the shunt machine the field coils have a comparatively high resistance, are connected in parallel with the armature and take only about 2 or 3 per cent of the full-load armature current. On this account, where the armature may have comparatively large leads and terminals, the field leads and terminals will be small, as in Fig. 7, and this can be used as a guide as to whether a motor is of the shunt type or not except in the small size, where the armature and field leads may be the same size.

In the case of the small-sized motor it may be necessary to make a test to tell if it is series type or shunt type. This can be done with a test lamp and circuit. If the armature and field leads cannot be easily followed to the terminals, they will have to be located by test, as indicated in Fig. 8. One terminal of the test circuit is touched to the commutator and the other to the motor terminals. The two terminals that light are the armature and the other two the field coils. When the field leads have been located, connect the test circuit to them as in Fig. 9. If the lamp is dim, it indicates that the field coils have high resistance and the machine is of the shunt type. On the other hand, if the lamp burns brightly, it shows that the field coils have a comparatively low resistance and the machine is of the series type. On the shunt motor a severe spark will occur when the test circuit is broken on the field lead, which will not be present when the test circuit is broken from the field terminal of a series motor.

If a test lamp is not available, the field and armature may be connected in series, as in Fig. 10, and the remaining terminals to the line. If the machine is series wound, it will start with a strong effort and will soon reach a high speed if not loaded. A shunt machine connected in this way may not start at all, and if it does it will run at a slow speed with a weak torque. In most cases it will not start at all, but if the armature is turned by hand, it will be found to have a greater tendency to turn in one direction than in the other, and when the field switch is opened there will be a severe arc.

In very small-sized machines the field coils may be connected in to the armature and only two terminals brought to the outside of the machine. When such a machine is connected to the line without load, it will race if of the series type; if of the shunt type, it will come up to and operate at the rated speed marked on the name-plate.

It can be remembered that series motors except in small sizes are seldom used other than in railway, electric-vehicle and crane service. In some cases they are used on small pumps, fans and blowers, but these are usually in sizes of two horsepower and less.

A compound motor has both a shunt and series winding on the polepieces. These windings are usually

made up separately and placed on the main poles, although in some cases on small machines the coils are taped together before they are placed on the polepieces and look like one coil, but they will always have four leads. The four leads from the two field windings with the two from the armature make a total of six. The series coils usually occupy about one-quarter to one-third the space on the polepieces required for the shunt-field coils and may be placed on either end of the polepieces, near the armature or back against the frame.

There are in general three ways that the leads from the field coils and armature of a compound motor may be brought out. First, as in Fig. 11, where one terminal of the series winding is connected directly to the brushes, as at *Y*, and an armature and a series field lead brought to external terminals along with the two shunt-fielld coil leads. In this arrangement the motor has the same number of terminals as ordinarily used on a shunt or series machine. Such grouping is seldom used except on small machines.

A common arrangement for the leads of a compound motor is that in Fig. 12, where a shunt and series lead are connected together inside the machine, as at *Y*, and five leads brought out. Before the motor leaves the shop, the polarity of the two sets of field coils are determined and the two leads (one shunt and one series) that will maintain this polarity correct are connected together. This greatly facilitates connecting the machine up when putting it into service and prevents getting it connected so that the two sets of field coils have opposite polarity.

Where the series field windings are cut out of circuit after the motor has been started, as in elevator work, the six leads of the motor must be brought to the outside so that the machine has six terminals, as in Fig. 13. In some very small motors the series winding may be connected in series with the armature and one side of the shunt connected to a series lead inside the machine. This groups the leads so that only three come outside the motor. Or again, one shunt lead may be connected to the free series lead and the other shunt lead to the free armature lead and these two leads, armature and series, brought to the outside of the machine, in which case there are only two terminals.

Just as the field-coil and armature leads are the same size in a series motor, so in a compound machine the series-field coil leads are the same size as those coming from the brushes, as indicated in the figures. With the exception of small machines the shunt leads are always smaller than the series and armature leads and afford one means of distinguishing between the different field windings. The difference in the size of the series and shunt field leads and terminal on large machines is very marked, the series leads being frequently made of copper bars.

On small machines where the field leads are all the same size, the series and shunt field windings can be determined by testing with a lamp. When the shunt coils are connected to the line through a test lamp, a dim glow will be obtained in the lamp on account of the high resistance of the coils, just as explained in the tests for a series or shunt motor, Fig. 9. When the lamp is connected in series with the series-field winding and to the line, it will burn brightly.

The series shunt or compound type of motor may have interpoles, which are small poles between the main pole, as shown in Figs. 1, 3, 14 and 15. These, however, do not change the number of terminals on the outside of the machine, since it is general practice to connect the interpole winding in series with the armature

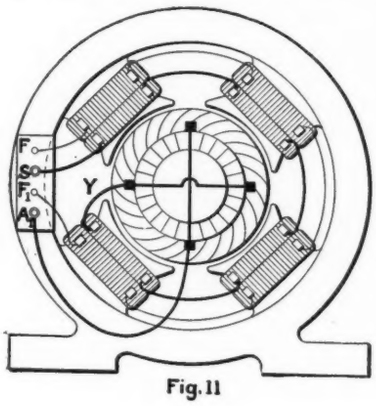


Fig. 11

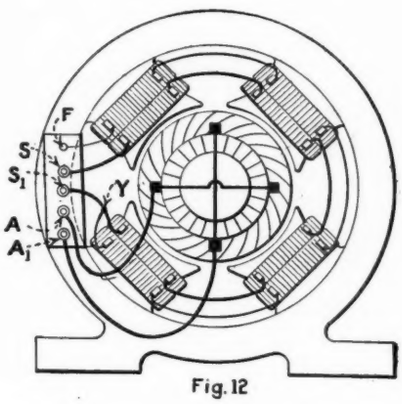


Fig. 12

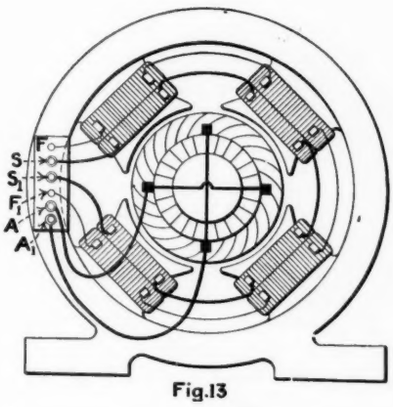


Fig. 13

Figs. 11 to 13—Show three different ways of bringing out the field coil and armature leads on a compound motor

Fig. 14—Shunt motor with one interpole for each main pole

Fig. 15—Compound motor with one interpole for each main pole

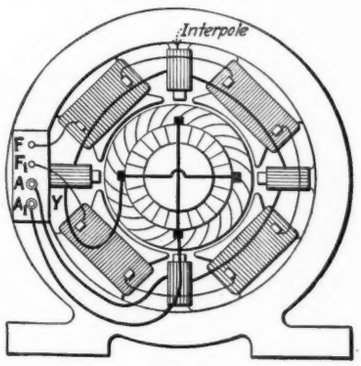


Fig. 14

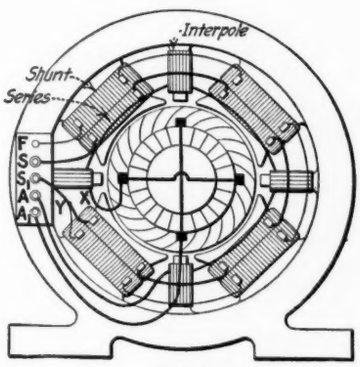


Fig. 15

within the machine and bring one interpole and one armature lead to the outside terminals, as in Figs. 14 and 15. Fig. 14 is a shunt machine with interpoles, but it has only four terminals as for the non-interpole type in Fig. 7. How the interpole windings and armature are connected inside the machine is clearly shown at *Y*.

In Fig. 15 the compound machine has interpoles, but as in the case of the shunt machine the interpole windings are connected in series with the armature at *X*, so that this machine can be arranged to have the same number of external terminals as for the non-interpole machine. The external terminals in Fig. 15 are the same as in Fig. 12, but they can be brought out as in Figs. 11 and 13.

In some interpole machines only one interpole is used for each pair of main poles, Fig. 1, while in others there are as many interpoles as main poles, Figs. 14 and 15, but this does not alter the external connections.

In Fig. 1 the difference in the size of the leads from the field coils can be clearly seen. The leads from the interpole coils *A* and the series coils *C* are large, whereas the leads of the shunt coils *B* are small, as indicated at *D*. In this figure the series coils are placed next the frame; in Fig. 15 they are next the armature. Either arrangement may be used which best suits the particular design. In Fig. 3 the shunt-field coil leads *D* and the armature leads *E* are easily recognized by their difference in size.

It is quite general practice for the manufacturers to mark the leads on the external terminals of the machine before sending them from the factory. If the machine is repaired, it is not always in reliable hands and in some cases these markings are mixed up, consequently the safest way is to check up on the machine's terminal before making the connections to the starting equipment. Such checking can be done as suggested in the foregoing and may save considerable time in getting the machine in operation.

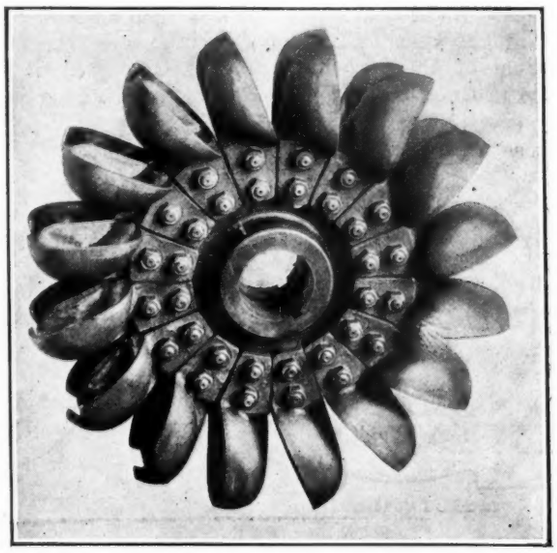
Preventing Corrosion of Hydraulic Turbines

During 1919 the Pelton Water Wheel Co. furnished for the municipal hydro-electric plant of Manizales, Colombia, a 500-hp. impulse turbine for direct connecting to a generator running at 450 r.p.m. This was the initial installation of what was expected to be a three-unit plant, the succeeding units to be installed as the load increased.

After the first unit was installed, it was noted that the waterwheel buckets and other parts coming in contact with the power water showed marked signs of wear, causing their too frequent renewal. As the result of an investigation it was found that the power water originated in territory containing considerable quantities of sulphur; in fact there are a number of sulphur mines in the vicinity. Also, during certain seasons of the year the water was heavily charged with cutting particles which, in connection with the sulphurous acid contents of the water, increased the tendency to erosion of the waterwheel parts.

The first unit was then remodeled by furnishing bronze buckets and bronze protective coverings for certain parts of the turbine equipment, and the whole was then coated with an asphaltum-base paint. A year's continuous run showed no appreciable wear of the bronze buckets. When the second unit was constructed during 1923, some changes in the metals of the turbine were employed, with the result that in addition to the bronze parts, monel metal was also used, with the idea of obtaining data as to the comparative wear and lasting qualities of bronze and monel metals under these conditions.

The present power house comprises two 500-hp. double-runner impulse wheels, and because of transportation difficulties the units were specially sectionalized. For example, the flywheel disk is one piece, but the heavy rim section is made in segments, all carefully balanced. Bronze, brass and monel metal are used for the rotating elements. For the wheel casing a protective paint is employed. No iron comes in contact with the power water. Rockshaft bearings are bronze-bushed and the shaft bronze-bushed or painted where necessary.



Impulse wheel with bronze and monel-metal buckets

A suggestion has been made that mercury be used in industrial heating systems when high temperatures are needed for process work. Attempts have been made to employ superheated steam, but the objection is found in the fact that the steam loses its temperature very rapidly. Mercury has high boiling points at low pressures. By evaporating mercury in a suitable boiler, the saturated vapor could be led to the heating element and after giving up its latent heat the mercury would return to the boiler. Since mercury shows but a slight temperature change for a large pressure change, temperature regulation would be easily obtained. For most process work the system could be operated sub-atmospheric, thereby eliminating all danger of the mercury leaking. The problem of boiler construction has been more or less solved in the late developments in the mercury turbine and boiler for power purposes; in fact, the process heating system could be operated in conjunction with a power plant. While a matter for future development, there is reason to believe that such a system will eventually be worked out.

Handling Oil-Fired Boilers

By Albert Smith

Very often oil has been defined as the ideal fuel. It has its advantages over coal because storage and delivery are greatly simplified and firing requires simple equipment and a minimum of labor. Fuel waste is easily controlled, no ashes need to be removed, smoke nuisances are avoided, and the boiler-room efficiency can be kept fairly constant regardless of the load. However, there are a number of details to which too scant attention is paid.

Three substances in oils may occur in such quantities as to cause considerable trouble; namely, sulphur, water and foreign matter. Sulphur burns to sulphur dioxide, which combines with moisture, forming acid. In exceptional cases a high water percentage may be caused by seepage into wells or oil-storage reservoirs. Residuum oils are better suited as fuel, because most of the water passes off with distillates in the refinery.

Every Oil-Fired Plant Should Have Two Pumps

Regardless of the system installed, two pumps, controlled if possible by an automatic governor, should be in every oil-fired plant. A relief valve in the discharge line should be installed to release excess oil pressure. An air chamber to neutralize pump pulsations, a thermometer and pressure gage are important and necessary equipment. Live-steam heaters are usually to be preferred, because oil can be raised to a desired temperature with very little steam and a better temperature regulation can be obtained than with exhaust steam. Steam for burners should always be taken from a point where it contains the least amount of moisture. The piping should have no pockets in which steam can condense and settle. The steam line should run directly from boiler to burner with an auxiliary connection to a header for firing up. All piping should be lagged.

Pipe threads must be cut carefully, and joints should be made up with freshly mixed litharge and glycerin or shellac. This is necessary because of the tendency of oil and oil vapors to leak through pipe joints. Shellacked canvas or canvas coated with litharge and glycerin makes an excellent gasket for flanged joints.

Temperature an Important Factor

The temperature to which oil should be heated is very important, though specific information cannot be given on this point because of the variation of viscosity for different oils; it lies generally between 100 and 140 deg. F. A good way to determine the best temperature is to heat up the furnace walls and then gradually open the steam supply to the heater until clear and steady flames are produced by the burner, assuming of course that the air supply is ample. The temperature at which this takes place should be noted and maintained. This is the reason why a thermometer in the oil supply line is indispensable.

In practice it is important, when selecting a burner, to know if the apparatus is of the short- or long-flame type. A burner of the long-flame type in a relatively short furnace may cause considerable trouble, because flames striking the opposite furnace walls may be reflected to the tubes, producing a blowpipe action on both wall and tubes. The discharge openings in burner tips must be cut with great care both as to size and finish, and if the openings become too large for good atomization, the tips should be renewed.

In the early days of oil firing much attention was given to burner-design details and too little attention was paid to furnace design. The best burner will give unsatisfactory results if the furnace is not correctly proportioned. When oil burns in the presence of but little excess air, a temperature close to 3,000 deg. F. will result, and if combustion takes place close to the tubes or shell, blistering and burning will result. Since combustion cannot be uniform, the furnace volume must be ample for good diffusion of the gases. Only first-class firebrick should be used. Firebrick arches and deflecting walls are not necessary in good furnace design. They are rather objectionable because they melt and burn at high temperatures. Very important are the location and size of air ports, for these ports affect not only the quality of combustion, but also the shape of the burner flame.

Starting Fire in a Cold Furnace

When starting a fire in a cold furnace, the damper should be opened; next, the burner steam valve should be opened about a quarter turn; a lighted torch should then be inserted and the oil valve opened just enough to produce a short flame. The torch should be left in the furnace until the flames burn steadily. Even when the furnace walls are hot, the oil should be shut off whenever a burner stops firing. It should not be reopened till a lighted torch is inserted, except where other burners are in service. Failure of firemen to take these precautions has resulted in flarebacks and explosions of sufficient force to wreck the boiler front.

Firing by the Eye

High boiler efficiency without guidance of instruments other than a pressure gage and thermometer can be maintained by a good fireman firing by eye. The greatest waste in oil-fired plants results from excess air admitted into the furnace, through neglect to adjust the damper and air doors properly.

For example, with 13 per cent CO_2 excess air is around 19 per cent and the chimney loss for a temperature of 450 deg. F. is about 9.5 per cent. For 8 per cent CO_2 excess air is 89 per cent and the chimney loss 15.21 per cent. The heating of the unnecessary air represents a waste of 15.21 — 9.5, or 5.71 per cent. The CO_2 should be maintained between 13 and 14 per cent at the damper; a higher CO_2 is undesirable as considerable CO may form, which increases the chimney loss.

If good care is taken and the oil pressure, temperature and air spacing properly maintained, only very little excess air is needed. The color of the most efficient flame approaching the shell or tubes is almost clear orange and will produce only a slight haze on the top of the stack.

Many Chimneys Are Too High

Chimneys higher than necessary are often found. They are objectionable because air regulation is very difficult and the induction of excess air is increased, resulting in a waste of fuel. The draft required for oil firing is considerably less than for natural-draft, coal-burning installations, but chimneys and stacks designed for forced-draft regulation will generally do, because allowance for furnace draft and excess air are greatly reduced and the gas volume per 10,000 B.t.u. in the fuel is about the same for oil and coal for equal percentages of excess air.

Removal of Scale with Carbon Dioxide

BY CHARLES L. JONES
Industrial Fellow, Mellon Institute of Industrial Research*

The removal of scale with carbon dioxide, far from being a cure-all, finds application for the most part to special problems. Where conditions are suitable, however, this method possesses a flexibility not characteristic of any other procedure in removing without shutdown, deposits not accessible for mechanical removal. It should prove especially useful in hot water systems where the practice heretofore has been to remove the deposits by replacing the piping.

FROM time to time the suggestion has apeared in the technical literature that certain types of boiler scale as well as deposits in pipe lines should be removed by increasing the CO_2 content of the water, and thus redissolving alkaline-earth metals as bicarbonates. Like most methods of water treatment applied indiscriminately, however, the results obtained have been inconsistent. In the few instances where the scheme has been tried, results have been in some cases very gratifying, and in other cases the addition of carbon dioxide to the water has had little apparent effect on the deposit.

The method of removing scale by treating with carbonated water is by no means universally applicable; but where the nature of the scale and all conditions are favorable, it is possible by this method to remove troublesome deposits from inaccessible places without shutdown. The writer believes that the information presented here may avoid unsuccessful use of the method under conditions to which it is not suited, and may aid in getting the best results with it in the solution of problems that cannot be met by the ordinary shop expedients or scale-removal systems.

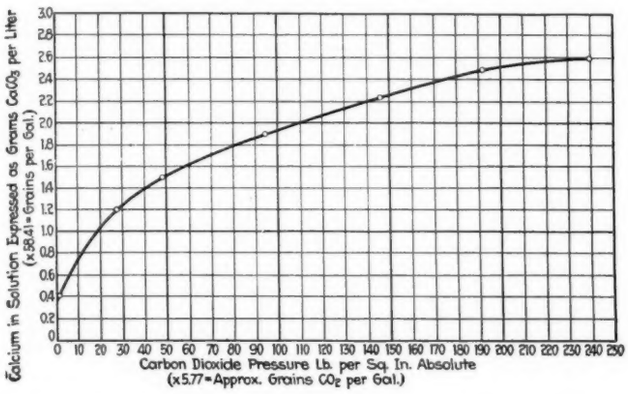
FACTORS AFFECTING THE REMOVAL OF DEPOSITS

In at least one instance recorded in the literature, carbon dioxide has been used with good success to remove boiler scale[1]. In this particular case the applicability of the procedure was tested in advance by subjecting a small sample of the scale to be removed to the action of carbonated water in a pressure bottle. This preliminary trial is indispensable, because only certain types of scale are amenable to the treatment, and failure is to be expected when carbon dioxide is applied to a scale without regard to its chemical composition or physical properties.

T. R. Greenhorne[2] has patented the application of carbon dioxide for removing scale "consisting of or containing carbonates," but, curiously enough, Cross and Irvin[1] find that the procedure works best in practice on scales high in silicates and low in carbonates. The reason for this apparent inconsistency will appear later.

In at least two recent instances, attempts have been made to remove scale with CO_2 without success, and in both cases the evidence indicates that the reason for failure was the limited solubility of calcium bicarbonate in water. Since only about one gram of calcium carbonate will dissolve in a liter of water saturated with CO_2 at atmospheric pressure, it is obviously futile to expect to remove carbonate deposits unless at least 120 gal. of water is used for every pound of calcium carbonate to be dissolved from the deposit, or a smaller amount if a higher pressure of CO_2 is used.

This consideration brings out the reason for success with scale high in silica. Where the bulk of the scale consists of compounds not soluble in carbonated water, but containing sufficient alkaline earth carbonates in the proper physical condition, a small volume of water —possibly one filling of the apparatus to be cleaned—


Calcium in Solution Expressed as Grams CaCO3 per Liter
(x58.41 = Grains per Gal.)
Carbon Dioxide Pressure Lb. per Sq. In. Absolute
(x5.77 = Approx. Grains CO2 per Gal.)

Solubility of Calcium Carbonate in Carbonated Water at 25 deg. C. (77 deg. F.), according to McCoy and Smith.

will dissolve enough carbonates to loosen all the scale that is present.[3]

Several investigators have studied the solubility of calcium carbonate in carbonated water[4]. The accompanying curve gives the solubility of calcium expressed as calcium carbonate at various carbon-dioxide pressures, taken from the results of McCoy and Smith[5]. Solubility also varies with the crystalline form of the calcium carbonate as well as with the temperature, the solubility decreasing with increase in temperature, at least in the range from 32 deg. F. to 100 deg.[6] The

TABLE I—SOLUBILITY OF $CaCO_3$ IN VARIOUS FORMS

Temperature Deg. C.	Temperature Deg. F.	Form of $CaCO_3$	Solubility, Per Cent	Pressure of CO_2, mm. of Mercury	Lb. per sq.in.
9	48	Aragonite	0.146	777	15.0
25	77	Aragonite	0.1066	762	14.7
35	95	Aragonite	0.0876	744	14.4
9	48	Calcite	0.130	777	15.0
25	77	Calcite	0.0943	762	14.7
35	95	Calcite	0.0765	744	14.4

*University of Pittsburgh, Pittsburgh, Pa.

[1]R. J. Cross and R. Irvin, *Power*, March 14, 1922.

[2]United States Patent 1,135,684.

[3]According to a private communication from R. E. Hall, physical chemist of the U. S. Bureau of Mines, most scales contain calcium carbonate as an incidental constituent, bound together by other materials, often hydrous magnesium silicates. The question of the nature of the binder in the scale is immaterial here, provided the carbonate phases are sufficiently continuous to cause the whole scale to disintegrate when the carbonates dissolve.

[4]Johnston and Williamson, J. Am. Chem. Soc., 38 (1916), 975; Kendall, Phil. Mag., (6), 23 (1912), 958; Cavazzi, Gaz. Chim. Ital., II, 46 (1916), 122; Seyler and Lloyd, J. Chem. Soc., 95 (1909), 1347; Hachnel, J. prakt. Chem., 1924, 165-76.

[5]McCoy and Smith, J. Am. Chem. Soc., 33 (1911), 468.

[6]R. C. Wells, J. Wash. Acad. Sci., 5 (1915), 617.

figures[7] shown in Table I are of interest in this connection.

The same principle, that is, increasing the solubility of calcium and magnesium by a moderate increase in carbon-dioxide content of water, has been successfully applied to a special problem in raw-water ice manufacture. It is likewise finding application in the carbonating of the city water supplies in Newark, Defiance, Ohio, and Oklahoma City, for preventing the deposit of carbonates in pipe lines and filters.

Cleaning Pipe Lines and Pumps at a Large Pittsburgh Steel Works

The following communication received by the writer is of interest in this connection:

Liquid CO_2 has been used at a large steel works in the Pittsburgh district for cleaning out pipe lines leading from the water softener to the feed-water heater and also for cleaning out the inside of feed-water pumps. In the former case the deposit consisted of approximately 50 per cent of calcium carbonate, while in the latter 95 per cent of calcium carbonate was present. The water passing through the pipe line contained approximately 0.35 grain per gallon of the radical $(OH)_2$ and about 3 grains per gallon of carbonate expressed as calcium carbonate. This latter was principally excess sodium carbonate added during the treatment.

From this it is evident that a considerable proportion of the CO_2 gas introduced was required in changing the caustic and carbonate condition of the water to bicarbonate before any excess free CO_2 could be present in the water. The excess CO_2 was carried at about 20 grains per gal.[8]

This condition was maintained for only eight hours during each day and resulted in a rapid disintegration of the scale in the pipe. It was felt that a wash period was required after each treatment to remove all the disintegrated material in the pipe, so that clogging at valves, bends, etc., would be prevented.

During certain seasons in the year it was found that so much excess carbonate and caustic treatment was required at the softener that the use of CO_2 gas would not be economical, so that the period in which pipe lines could be cleaned by this method was limited to that in which low treatment was required at the softening plant. The results showed very satisfactory removal of the incrustation from the lines. In the case of the feed-water pumps, with a scale which was practically pure calcium carbonate, each pump was blanked off and the required pipe connected to the outlet. With the pump turning over slowly, so that a circulation of water through the casing would result, the CO_2 gas was introduced into the casing and the pressure maintained at 60 lb. for a period of two or three days. This required approximately 400 lb. of CO_2 gas. An inspection of the pumps after cleaning showed the impellers with all incrustation removed and only slight patches of incrustation in dead spots in the casing. On the whole, the method proved very satisfactory.

Practical Considerations

As a result of experience the following points are suggested for the consideration of engineers who have problems in the removal of deposit from pipe lines, etc.:

1. The first step in any case is to determine empirically the action of carbonated water on the scale to be removed, using for the purpose the water with which it is proposed to remove it. Cross and Irvin[9] have described a simple and inexpensive apparatus in which this test may be made. If the aid of a carbon dioxide manufacturer is sought, he can send samples to the writer for test.

2. It is especially important in the foregoing test to use the proper ratio of sample to water, so that sufficient water will be present to dissolve the alkali-metal carbonates from the sample. The writer prefers to use a small piece of scale weighing not more than 0.25 gram in 250 c.c. of water.

3. When a chemical analysis is available, some study of the scale composition will prove worth while. Where analysis shows a comparatively small percentage of alkali-metal carbonates in the scale and the pressure-bottle test shows good disintegration, it may be concluded that the carbonate phase in the scale is sufficiently continuous to be disintegrated by carbonated water, and that a large amount of scale can be loosened with a moderate amount of gas and water.

4. Since the solubility of calcium bicarbonate is greater in cold water, it is advisable to remove scale with cold water where any choice may be exercised in this respect. It is obvious that this is true where there is free escape for the gas, since temporary hardness, or rather the temporary nature of the hardness, is due to the familiar phenomenon of calcium carbonate depositing when carbon dioxide is boiled off. While not so obvious, it is likewise true that waters held without loss of carbon dioxide have greater capacity to take calcium into solution cold than hot.

5. Consideration must be given to the nature of the piping or apparatus to be cleaned. When it is desired to clean pipe lines without shutting off the water passing through them, it will be found impracticable as a rule to saturate the water with calcium or to bring the scale into equilibrium with the concentration of CO_2 as HCO_3 in the water. Under these conditions application of CO_2 at a moderate rate should be continued over a considerable period of time. On the other hand, in the case of piping systems that are to be cleaned of scale while not in use, the system can be filled with water either saturated at atmospheric pressure or under the higher pressure of the CO_2. When this water has become saturated with calcium, it must be drawn off, and the operation repeated, until the condition of the system is satisfactory. In favorable instances, such as the boiler-scale experiment cited above, the deposit will be disintegrated with one filling of the apparatus, and can be flushed out.

6. No fear of corrosion need be entertained due to the use of carbon dioxide. On dissolving carbon dioxide in water, the hydrogen-ion concentration (acidity) of the latter increases, and this results in accelerating corrosion *where oxygen is present*. In the absence of oxygen no commercially important corrosion will be experienced, and in the presence of small amounts of oxygen the use of high concentrations of CO_2 for short periods in cleaning out deposits will be found in practice to produce a negligible amount of corrosion of iron or steel[10].

Some operating companies make a practice of carefully observing air leakage by actual measurement, some of them permanently installing a rotative dry vacuum pump piped up as to connect to any condenser. The air discharge is measured by means of an air bell, the regular air pump being closed off and the unit operated at reduced vacuum during the brief time of the observation.

[7] Backström, Z. physikal. Chem. 97 (1921), 179.

[8] 20 grains per gal. free CO_2 is the equivalent of distilled water saturated with CO_2 at approximately 60 deg. F. and 2.5 lb. absolute partial pressure of CO_2, or 77 deg. F. and 3.5 lb. absolute. See the curve.

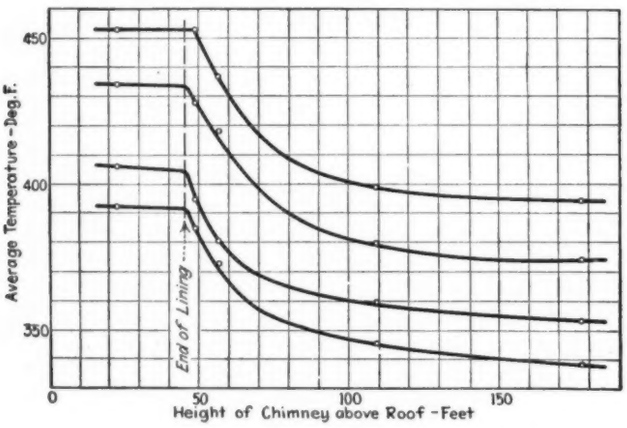
[9] *Power*, March 14, 1922.

[10] Shipley and McHaffie, Canadian Chem. and Met., May, 1924. Corrosion in the absence of oxygen may be only 1/250th as fast as with oxygen present, and in any event the relatively short time of CO_2 application, together with the protective action of the scale, make any corrosion unimportant.

Rational Chimney Design

By N. T. Bourke*

The design of chimneys for proper draft and capacity is still largely conjectural. Indeed, it is probable that the subject is today more chaotic than it was two or three decades ago. The high ratings at which modern boiler installations are operated, together with the use of low-grade coals formerly considered unburnable and valueless, have rendered obsolete many tables of chimney heights and diameters in which the basic factors were either the rated boiler capacity served, or the pounds of coal burned per hour. On the other hand, there are available very little reliable data on which a more rational method of chimney proportioning can be based. Consequently, although much excellent work



Variation of gas temperature along chimney

has been done, there is little published today that is really authoritative, and much that is conflicting and unsound.

Many Factors Dealt With

The rational design of a chimney for a predetermined draft and capacity deals with such factors as weight of gas handled, composition of gas, altitude, outside temperature, temperature of gas, etc. Of these all can be easily determined or closely predicated except the one item of temperature of gas, which is perhaps the most important of them all. The draft of a chimney is of course due to the different densities and weights, and consequent pressures, of the column of hot gas in the chimney and a similar but imaginary column of comparatively cold air outside. Any variation in the temperature of the chimney gas will therefore have an immediate effect on the draft.

The temperature of the chimney gas is not constant from bottom to top, but variable, decreasing steadily owing to loss of heat by radiation and to infiltration of cool air through the chimney. The average temperature is therefore lower than the incoming temperature, and consequently the actual draft will be less than the calculated, unless due allowance be made for this factor.

Unfortunately, our knowledge of the precise nature of this drop in temperature is very meager. The late Alfred Cotton, in his paper on "Chimney Sizes," presented to the American Society of Mechanical Engineers, May 28, 1923, summed up the situation as follows:

> There are not sufficient data as yet to give more than a fairly approximate idea of the mean temperature of the gases in any given chimney. . . . Generalizing from one or two cases is not usually advisable, but in this case it is wiser to generalize in this way than to do nothing at all.

The "one or two cases" to which he referred, and which formed the basis of an elaborate series of curves which he developed, were the tests conducted under the direction of Prof. Ed. Miller, of the Massachusetts Institute of Technology, published in "Steam Boilers" by Peabody and Miller, and those by J. C. Smallwood, published in *Power* of Sept. 16, 1919. These tests—some eight in all—were conducted on chimneys best adapted to testing, but the experimenters nevertheless worked under great difficulties.

It has for some time been realized that existing chimneys are so inaccessible and difficult of test that complete and reliable data could be obtained only from new chimneys especially constructed for testing. Such chimneys should be constructed with platforms or other devices at several elevations, from which, through special doors or openings, access could be had to the interior. Within the last year several chimneys have been built or are being built in which such provision has been made. It is to be expected, therefore, that accurate data of chimney performance under a great variety of conditions will be available, and rational chimney design greatly simplified.

Gas Temperature Variation

Tests are now being conducted on one of these chimneys. Although the information so far gathered is fragmentary and not ready for publication, the accompanying chart, showing the temperature gradient of the chimney gas of this chimney at various degrees of incoming temperature, is presented as a sample of the kind of data now possible.

This chart has two rather noteworthy features. First, the chimney lining very evidently reduces the temperature drop to a minimum and materially increases the available draft. Second, the average temperature of the chimney gas above the lining is in each case about 90 per cent of the incoming gas temperature. It is inadvisable, however, to draw any sweeping conclusions from this, as it is based on four tests only.

It may be seen from the foregoing that, although the correct design of the chimney is at present the most difficult feature of a power-plant design, there is excellent prospect that within a few years this unfortunate situation will be entirely corrected.

[For a detailed discussion of the principles of chimney design see the article on chimney sizes, by Thomas S. Clark, in the July 29 issue.—Editor.]

Many workmen daily confuse the real purpose of a wrench with that of a hammer. Their guiding principle for the moment appears to be, "A wrench in the hand is worth two hammers on the bench." There is an old saying to the effect that every man uses his thumbnail as a screwdriver *once*, and that he uses his monkey-wrench as a hammer until the boss catches him.—*Traveler's Standard.*

*Purdue University, Lafayette, Indiana.

Make the Plant the Pride of the Operators

WHEN only the broad problems of a power plant are considered, they may be divided into two groups—those relating to the design and construction and those that are involved in the operation of the station after it has gone into service. Frequently, insufficient attention is given to the latter when the station is designed. This not only applies to the small-sized industrial power plants, but is also true of the large stations both industrial and central. The way that some plants have been designed and the arrangement of the equipment in them show that the designer had little knowledge of operating problems or, if he did, ignored this vital point entirely.

It generally requires one or two years to design and build a plant, but it must be operated from approximately ten to thirty or more years, depending upon the rate of obsolescence of the equipment. Furthermore, the plant is generally erected under favorable conditions, with an adequate number of men and hoisting equipment, where the machinery may have to be dismantled from time to time after the plant has gone into operation with relatively few men from the operating staff. These conditions should be given careful consideration in the design of the plant and every possible convenience provided to assist the operating staff in inspecting and maintaining the equipment. If small equipment is located in inaccessible places and the large pieces of machinery are not provided with the proper stairs and walkways, the operator can hardly be blamed for the neglect in inspecting the apparatus. When those who are responsible for its design and construction do not take pride enough in the plant to make it reasonably safe to operate, the attendant can hardly be blamed for not wanting to risk his life unnecessarily.

Another feature that is too frequently overlooked in the design and construction of power stations is the general appearance of the plant. The difference between the cost of a building that possesses architectural merit both outside and in when properly done, is a very small part of the total cost, and this cost is warranted by the general attitude of the operating force toward their work. If operators have to work in an ill-lighted plant with dark and dingy walls and machinery, their attitude cannot be the same as in a plant that is well lighted and in which the general surroundings have been given a pleasing appearance. One has an atmosphere that induces lack of interest; the other is a thing of pride. When a plant becomes the pride of the operating crew, one of the biggest factors in economical operation of the plant has been accomplished.

Some progressive power-plant designers have sensed the psychological effect of the general appearance of the plant on the operating force and not only give careful attention to operating conveniences in the design of the plant, but also endeavor to give consideration to its architectural features. This is done by an architect after the design of the plant has been decided upon. Of course power plants must first of all be designed to operate efficiently, but after the equipment has been decided upon and the dimensions of the building to house it are determined by competent engineers, then the architect can do a valuable service, at little additional cost, in the appearance of the plant.

Power-Plant Standardization

A BULLETIN issued by the American Engineering Standards Committee, representing practically all of the professional engineering societies as well as important industrial groups and governmental departments, says, "Standardization is today the most important approach to greater industrial efficiency." Attention is directed to the fact that the automobile industry alone, through its organized standardization activities, is making estimated savings of $750,000,000 a year.

Certain classes of power-plant equipment have reached a high stage of standardization. This is particularly true of electrical equipment such as switches, transformers, etc. In the mechanical end of the plant the outstanding examples are piping and fittings. The standardization of pipe threads was recognized as a practical necessity many years ago. Here the question of ease of manufacture was subordinate to that of interchangeability in the field.

One of the most important obstacles to national standardization of power-plant equipment is the patent foundation of the industrial structure. As a reward for making a discovery or improvement, the government grants an inventor a monopoly for a certain period of years. Without this incentive the wonderful developments of recent years would never have taken place. Granting the absolute necessity of patent protection, it follows at once that complete standardization throughout an industry is possible only on unpatented equipment or features or on those where the patents have expired. The sizes of lumber, boiler tubing, screw threads and firebrick evidently fall in this class.

Another obstacle to standardization, both within an industry and within a company, is the necessity of making provision for technical progress. There is a steady improvement in the efficiency and general effectiveness of power-plant equipment from year to year.

The tendency of standardization to halt scientific progress is fully recognized by the American Engineering Standards Committee. They do not urge its indiscriminate application, but only ask that the possibility of lowering production costs in this manner be kept in mind. There are doubtless some real opportunities to "Henry Ford it," even in the power-plant.

Purchasing Power-Plant Equipment

PURCHASING power-plant equipment, cannot be done on a price basis only, if the greatest return on the investment is to be obtained. A great many factors that affect the ultimate price of the machine, such as efficiency, reliability, durability, ease of repair, etc., must be considered. Nothwithstanding these well-recognized principles, it is not uncommon to hear of contracts being awarded involving thousands of dollars where about the only thing considered was the price.

In purchasing machinery there are many operating conditions encountered, that must be given careful study if an intelligent conclusion is to be arrived at. Where the equipment is to be used intermittently and reliability is not a deciding factor, the lowest-priced apparatus that will do the work may be found the most economical. On the other hand, where continuity of service is of first importance, the purchase price becomes of secondary consideration if durability and reliability can be obtained.

Efficiency of power equipment is something that cannot be overlooked, as frequently the higher-priced and more efficient equipment will pay substantial dividends over lower-priced and lower-efficiency apparatus, not considering the greater reliability that the higher-priced equipment may have. Take the case of a ten-thousand horsepower waterwheel operating under a yearly load factor of seventy-five per cent and the power sold at the low rate of twenty-dollars per horsepower-year. Figuring on a capital charge of fifteen per cent, an additional ten thousand dollars can be spent on the turbine for a gain of one per cent in efficiency. The same reasoning applies to the durability of the unit in maintaining its efficiency. Considerable expense can also be incurred in order that the turbine can be easily inspected and repaired.

What applies to a hydraulic turbine holds true for almost any piece of power equipment.

A Rating for the Human Element

A STUDY of the recent reports of various engineering associations concerned with fuel and power production shows a rather surprising and unfortunate failure to appreciate the importance of the human element as a factor in fuel conservation. As one would expect, superheaters, mechanical stokers, fuel and methods of operation are given great prominence because of their influence in effecting economies. But ultimately the problem devolves upon the human element, for it finally determines the economy of the fuel used, regardless of the apparatus employed.

Frequently, an article is published about some modern plant, interesting because of its size, some new innovation or some unique practice. Operating conditions may be discussed, pictures presented of apparatus and plans of layout, but little is heard about the men who run the plant. Apparatus is tested; but men are accepted "as is."

The human element is one link in the long chain of power production. It is the one link that is usually neglected and that rarely comes in for the consideration that its importance warrants. Too often the human element jeopardizes the fuel-saving possibilities of costly equipment and tends to counteract ingenious ideas and unique innovations carried out at a heavy expense to make possible some small saving.

Lack of training, lack of *esprit de corps*, lack of co-operation or inducement or encouragement may nullify all these. Yet these are, perhaps, the most easily procured and maintained assets in the plant.

We need a common denominator, a common basis of comparison by which to compare. promote and reward those engaged in the task of producing power from fuel. It would seem that this is the next step toward fuel saving.

Keeping Up with Engineering

IT IS utterly impossible to "learn" engineering once and for all. Practice changes almost from day to day.

To bring this fact home, it is only necessary to picture a reasonably experienced and well-read engineer dropping out of civilization five years ago and returning to his desk today. He picks up the latest issues of various technical journals and thumbs over the leaves. Along with many old friends in equipment, principles and methods, he finds a bewildering host of strange terms and strange ideas.

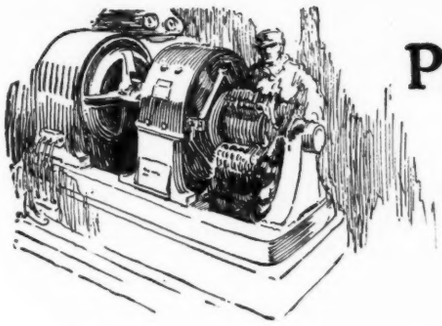
One article takes up the question "Is the House Turbine Passing?" The reader is bewildered. "Passing?" He never knew it had arrived. In fact he has never heard of a house turbine before and wonders whether it is something one puts in the cellar to light the home. Then he reads about bleeder heating and the regenerative cycle. Both terms are equally strange, although he once prided himself on his understanding of the Rankine cycle. Next his eye is caught by a few paragraphs about "deaëration." He guesses rightly that this is a highbrow name for air removal, but wonders how it can stop corrosion. "Isn't corrosion caused by water and acid?" he muses. A moment later he sees something about the steam accumulator, a "flywheel" for boilers, but shaped like a Zeppelin. By this time he begins to realize that in five years' time he has changed from an up-to-date engineer to a back number.

This impression deepens as he reads on about air preheaters, schemes for the maintenance of heat balance, the relative merits of unit and centralized equipment for burning pulverized fuel, water-tube furnace walls, steam pressures measured in four figures, house generators on the main-unit shaft, generator air cooling, electrostatic dust precipitators, electrical CO_2 recorders, automatic centralized combustion control, mercury boilers, stage reheating and low-temperature carbonization.

The picture is not overdrawn. Practically every one of these developments was unknown five years ago to the average intelligent engineer, even where they were actually in existence at the time. Some of them are unknown today to those engineers whose heads have been buried exclusively in their own plants.

No man, however well endowed with natural gifts and a good start, can keep up with modern engineering without continuous study. Information must be picked up wherever possible. Practical experience, plant visiting, participation in engineering meetings, the systematic use of reference books and fundamental textbooks and the regular perusal of the technical journals are essential to the highest success.

Fortunately, all this "work" becomes a pleasure after one gets into the swing of it. There is no satisfaction like that of knowing a job from the ground up.

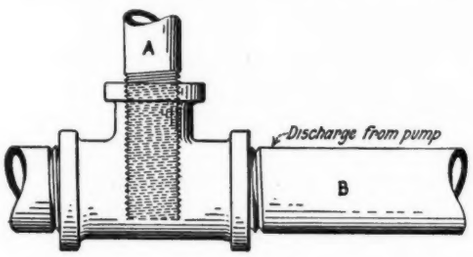


Practical Ideas *from* Practical Men

Why the Pump Failed To Operate

Some time ago I was called to a power plant to locate some trouble in a duplex pump. I was already aware that considerable discord existed among the employees, including the chief, so I conducted my inspection accordingly.

A casual examination of the pump showed the valves, etc., to be apparently in good condition. Suspecting spite work from some disgruntled helper, I started looking for the trouble outside of the pump. After disconnecting some of the pipes, I located the connection as shown in the illustration. The 1½-in. branch pipe *A* had been threaded long and screwed in almost to the back of the reducing tee on the pump discharge. When this connection was replaced by a proper one, the operation of the pump was much improved, but it was not possible to secure more than 125 lb. pressure.



'ranch pipe was threaded long and reached to back of tee

Upon examining the pump more carefully, I discovered that some time in the past a defect had existed in the partition between the discharge and suction valve chambers, and had been repaired by drilling and tapping holes and screwing in ¾-in. pipe plugs. Some person had removed several of the plugs, allowing a bypass through which the water could surge from one chamber to the other, thus making it impossible to obtain the desired pressure. Screwing in plugs to replace the ones that had been removed ended the trouble.

Toronto, Ont., Canada. JAMES E. NOBLE.

Use of Tube Pockets Prevents Boiler Shutdown

Recently, in a small isolated plant a bent water-tube boiler was taken off the line for the routine cleaning over Sunday. An external inspection of the first bank of tubes revealed a leak in two of the tubes about 12 in. above the mud drum. The leaks were on the back side of the tubes close to the baffle wall, making it difficult to see the exact nature of the defect. The surface around the leak was cleaned off and a water test applied raising the pressure in the boiler to 150 lb. The leaks then became so serious that it was deemed necessary to replace the defective tubes at once. However, on going over the supply of tubes none of the proper length and curvature were found.

As the boiler was needed the following day in order to carry the full load, it was essential that a temporary repair be made as quickly as possible. A welding torch being in the plant, the bad tubes were hastily cut out, being cut in several places to save time in removing. Four sound pieces about 12 in. long were afterward cut from one of the tubes. Then one end of each piece was heated and bent so as to close the end in the form of a cone, the end being carefully welded. These stub pockets were then rolled in the drums the same as a boiler tube, and after a water test had been applied, the boiler was put back in service and operated with the tube pockets in place for a period of two weeks. In the meantime tubes of the correct length were secured, and when the boiler was again taken out of service, the pockets were cut out and the new tubes rolled in.

By the substitution of the tube pockets an expensive shutdown was avoided, and while the theoretical capacity of the boiler was reduced, it was not noticed when under load. The upper pockets collected some mud and, if left in the boiler for any length of time, would have become burned. H. M. TOOMBS.

Chicago, Ill.

Getting the Most Out of Mechanical Soot Blowers

Theoretically, it is a simple matter to know when the soot blower should be used by watching the stack temperature. Knowing the amount of steam consumed by blowing and the cost per thousand pounds, the cost of blowing can be balanced against the waste of fuel resulting from the presence of soot and flue-gas dust on the heating surfaces.

Of course stack temperature is not an infallible guide as to soot, as it may be affected by many variables and can be intelligently interpreted only when at least two of these are known—steam flow and percentage of CO_2. The stack or breeching temperature is only part of the tale. The condition of the fuel bed, the rate of combustion, the condition of the heating surface, furnace and combustion efficiency, the characteristics of each individual furnace, the fuel and air infiltration—all play their part in making the stack temperature what it is at any instant. Yet stack temperature is the safest guide as to when to blow the soot.

How many engineers do know even approximately how much steam each element of their blowers consumes? How many know what their steam costs per

thousand pounds? How many know whether all elements or which elements should be blown for one-half minute and which for a full minute; or whether tubes should be blown every six, eight or twenty-four hours? These things can be determined only by experimentation, close observation and a knowledge of the facts.

The engineer cannot work intelligently without tools. The soot-blower manufacturers make the equipment; they send their service men around once or twice a year and provide adequate operating instructions. But in the final analysis, as always, it is the man on the job who controls the situation. He is the determining factor in keeping down the cost of maintenance and keeping up the over-all economy of the soot-blower installation.

So, once again, we find that even mechanical soot blowers cannot be operated intelligently without the "big three"—the CO_2 meter, the steam-flow meter and the stack thermometer, to which we might add a fourth, the thermometer in the superheater.

Soot blowing needs to be more than mechanical. It needs to be done more conscientiously with greater intelligence based upon more knowledge than is ordinarily available. Like economizers, superheaters, the blow-down valve and water softener and many more boiler-room accessories, the soot blower cannot be operated with maximum results without intelligent manipulation by properly informed personnel. The secret of results is adequate boiler-room records and all they imply.

K. RANKIN.

Chicago, Ill.

Bending Large Conduit with Home-Made Equipment

Bending conduit, large conduit, three inches and upward, has always been the *bete noir* of the erection men. Many men o' many minds is time in this case as in others. So all sorts of schemes have been developed. Each man has his own ideas and they are hard work and some are harder.

Heavy posts set in the ground, "dead men," chain-fall anchorages, filling the pipe with sand, heating it red hot, etc., all have their champions. So, when one man said, "Don't bother to send me any 4-in. elbows, I'd rather make my own," it gave us "furiously to think," as our French friends so aptly put it.

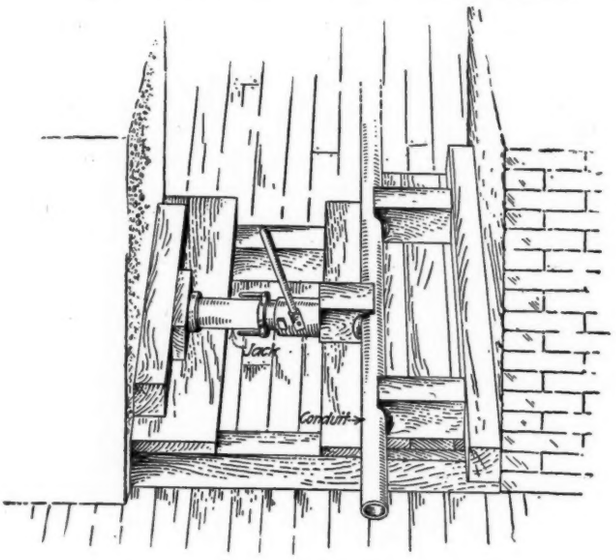
An inspection of the job and the methods used was interesting and instructive. Long sweeping bends, offsets around obstructions, changes of plane and direction with several conduit in parallel, and really parallel, made a beautiful, clean-cut installation. The bends and turns could not have been improved if the conduit had been one-half inch instead of four.

The galvanizing was bright throughout, no signs of heating or bruises, nothing but the marks of the pipe vise and pipe tongs, so we had to have a look at the pipe bender. It was so simple and so effective that it deserves wider distribution. One of the younger men said, "It's fun to bend big pipe with this outfit."

The stack foundation was about six feet from the side wall of the basement. Two pieces of timber had been laid on the floor between the stack foundation and the wall and planks laid across for a working platform. Not at all necessary, but they were borrowed from near-by piles and cut out stooping by raising the work off the floor.

The outfit proper consisted of a 25-ton jack, two 6x8 blocks about three feet long, and a third 6x8 about a foot long. One end of each piece of 6x8 had been gouged out roughly to the curve of the conduit, and the short one was crowned as well as gouged. The two long blocks were placed on their sides against the basement wall; the jack rested against blocking on the stack foundation and the short block was on the head of the jack. The figure gives the general arrangement of the various parts.

The distance between the two long blocks could be altered and the pipe moved as the bending progressed. The travel of the jack is slow, so there is little danger of nicking the conduit. Of course it takes some practice to get the best results with this arrangement, but the equipment can be easily obtained and there is always some place in a building where the walls are heavy enough and there is sufficient room to handle the work.



Jack in place for bending conduit

N. L. REA, Construction Engineer,
Schenectady, N. Y. General Electric Co.

Proper Care of Return Valves Obviates Replacement

Several instances have come to my attention where good return valves on heating systems have been discarded owing to failure of the operating force to clean this sensitive apparatus a few times during the heating season. Valves of the thermostatic type will pass some steam if there is a thin film of rust or cylinder oil on the expanding element, and of course if this is not cleaned out a considerable loss in steam and fuel will be caused.

In our plant we go over each return valve regularly. We remove the thermostatic element, dip it in benzine to loosen the rust and oil, then brush it off with a soft bristle paint brush until the element is clean. Each valve on the system is gone over in this way before the heat is first turned on and several times during the heating season. This eliminates the use of cold-water injection at the vacuum pump except as may be required for makeup water.

JOHN R. ANDERSON.

Baldwinville, Mass.

Comments from Readers

Boiler-Room Logs

One of the practical questions that every progressive engineer runs up against is, What is the best method of keeping records of daily boiler-room operation? I have been searching for a standard form, but without success. However, one of the oil-burner companies has kindly furnished me with the following list of data which should, in their opinion, be recorded in a boiler plant using fuel oil:

Numbers of boilers in service.
Rated capacity of boilers in service.
Steam pressure.
Fuel-oil pressure.
Furnace pressure.
Temperature of oil at pump suction.
Temperature of oil at burners.
Temperature of furnace.
Temperature of boiler room.
Temperature of feed water.
Temperature of flue gas leaving boiler.
Temperature of steam if superheated.

I believe a discussion of this subject in the correspondence columns of *Power* would be of practical value. Reproductions of forms or log sheets that have proved of value in actual service would be particularly interesting.

JOHN L. MCCARTY.

Boston, Mass.

"Management Savings?"

I have read with some interest and at times, no little amusement, the controversy now so active between the advocates of the isolated plant and purchased current. However, it has been my experience that in the majority of instances, by a combination of the proper engineering advice coupled with a selection of the type of plant equipment suited to the needs of the installation, the claims made for the elimination of the power house and engineer could be disproved.

The management should be trained to solve the power question in the same able manner that it is able to care for the manufacturing problems. If that is impossible, it should see the advisability of retaining as a part or whole time member of the organization, one who had advantages of the training that enables him to give the problem the correct analysis. I am firmly convinced that three much-to-be-desired ends would be accomplished by either of these two plans: First, the management would be enabled to show a much reduced operation cost; second, by combining heating and power generation, conservation of fuel would become a matter of fact; last but not least, in case the management decided that it would be advantageous for them to install their own power-generation equipment instead of a low-pressure heating plan only, it would not be possible for some enthusiastic salesman to sell the prospect a high-economy prime mover when what was really needed was a sublimated reducing valve that would make the steam do some work on its way to performing its real chore for seven months out of the average year of heating the factory.

In my work I have been on both sides of the frame; that is, selling and purchasing factory and power equipment. I have had men who were carefully and thoroughly trained in sales engineering, attempt to justify the investment made necessary by high-economy prime movers when, if an analysis had been made of the situation, it would be so glaringly apparent that any expenditure made over that represented by the purchase of the substantially and properly functioning single-valve engine would be absolutely thrown away.

What difference does it make to the plant what the number of pounds of steam used per horsepower as long as the total for the unit of time is not in excess of the requirements of the plant for heating or process work? What is the advantage of having installed in the engine room a prime mover that requires but 18 lb. of steam per horsepower, when the processes out in the factory "holler" for steam at the rate of 28 lb.? What is the advantage of putting ten dollars to do the job that six would do just as well? Often we hear claims that by shutting down on the isolated plant, buying power and using low-pressure steam for heating, thousands of dollars have been saved, but how much more would a real engineer be able to save if the plant was so equipped as to generate all the power required in addition to the heating of the shops, etc., for the same coal that is now used for heat alone? Of course I am overlooking the fact of the presumable enormous saving that is referred to so often as resulting from the elimination of the engineer.

L. E. POLLARD.

Canton, Ohio.

Oil-Burning Methods

In an article entitled "Oil Burning Methods" in the Aug. 26 issue, the question is asked, "What is the proper oil pressure to carry at the burners?" and the answer given was as follows: "Find out from the manufacturer of your particular type of mechanical burner the proper pressure to carry on your system with their burners to get good atomization. Once this pressure is determined, maintain it constantly, regardless of load conditions." As this answer is somewhat out of line with my experience I would like to ask, "How would the demands for steam be met? If by changing burner tips, would not this be impracticable in large plants where frequent changes in load might occur?"

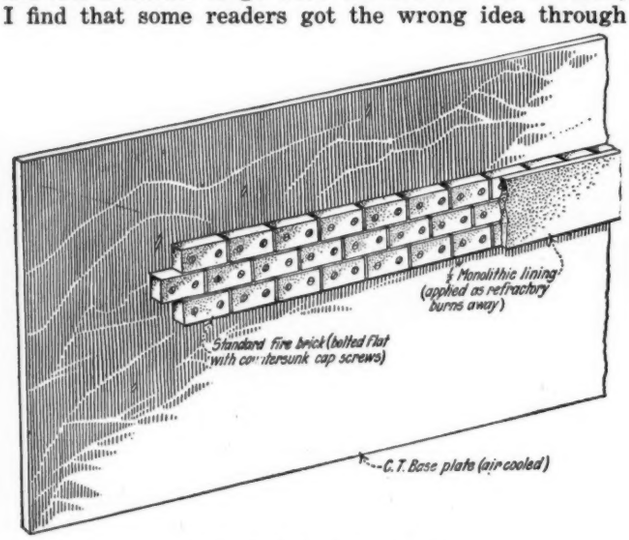
The various mechanical burners with which I have had experience have a considerable range of pressures at which the oil will atomize, and the burner tips are changed only at the extremes, the demands for steam (within the range of the tips) being met by variation of pressure. This method gives quick and easy control of fires, the size of all fires being changed an equal amount at once.

Pressures in excess of what the system is designed for should not be used. When the maximum pressure has been reached and more steam is required, a larger burner tip should be employed. G. W. HARRISON.

Houston, Tex.

Furnace Lining

In connection with the discussion on "Furnace Linings" in *Power*, July 22, the illustration shown was one not intended to go with the article. As a result, I find that some readers got the wrong idea through


½ Monolithic lining (applied as refractory burns away)
Standard fire brick (bolted flat with countersunk cap screws)
C. I. Base plate (air cooled)

Suggested furnace wall

paying too much attention to the illustration and not enough to the text. The construction actually suggested is along the lines of the sketch herewith shown. This consists of firebrick bolted to a cast-iron plate, and with a lining applied to the fire side. Since the temperature gradient through firebrick is steep, the furnace heat does not penetrate or soak into the brick as it usually does. G. B. RANDALL.

Dayton, Ohio.

The Master Mechanic

I should like to take exception to some statements in the editorial in the Aug. 26 issue entitled "The Master Mechanic." Granting the able manner in which the editorial is written, it does not present the master mechanic or maintenance engineer in his true light. Such men do not "sit and sun themselves" nowadays, even if they are deep in thought, at least not in the rubber manufacturing business. Neither can we say today that he "does less and draws more money than anyone on the job."

The present-day maintenance engineer probably does more walking and looking than any other person in an industrial plant. "Prevention" has largely replaced "cure." When he thinks, you can rest assured that he is doing it on his feet.

The master mechanic must do this to hold his job. If he sacrifices neatness and order, such condition is reported to the treasurer by the insurance company, perhaps affecting the rate and in all probability affecting the salary of the master mechanic. If accidents occur, the greater proportion being non-mechanical, it shows in the liability rate that the master mechanic is not checking up on the safety situation. There are numerous outside interests continually checking up on him.

The old-time idea of the master mechanic's being similar to a fire department is rapidly disappearing. The present-day master mechanic is constantly on the move seeking ways and means to prevent breakdowns, to stop waste and to guarantee production of goods whenever required. He certainly cannot fulfill these conditions and "do less than anyone on the job."

H. A. COZZENS, JR., Mechanical Engineer,
New York City. American Hard Rubber Co.

Leaky Compressor Valves

In *Power*, May 15, John Cassiday gives his theory on the question of leaky air-compressor valves, but it seems to me that there is a flaw in his reasoning. He argues that the addition of a quantity of the high-temperature air leaking back into the cylinder from the discharge side of the valve raises the initial air temperature, causing the discharge temperature to be somewhat higher than before; this action is repeated until often the valve becomes red hot. He apparently believes that the temperature of the valve is due to the temperature of the air.

My experience does not bear out this deduction. On one occasion I noticed that a certain poppet discharge valve on a compressor delivering air at 15 lb. pressure was a different color from the rest of them and that it was smoking. Trying it for temperature, I found that it was excessively hot, dangerously so. I got it off the line as quickly as possible and examined the valve, finding a piece broken out of it. Within the last three or four years I read of a water hose that caught fire while water was passing through it. The only unusual condition in connection with the incident was that the water was flowing through the hose at a very high velocity. What is the answer in both cases? The temperature was due to friction and not to the initial temperature of either the air or the water.

I believe, therefore, that Mr. Fitzgerald is right when he says, in *Power*, July 29, that the temperature of leaky valves is increased by the passage of air, due to friction, but wrong when he says that the statement that the valves become excessively heated due to friction is open to question. If friction in a water hose could set the hose on fire, there must have been excessive heating, and it would be much easier to raise the temperature of a compressor valve to an excessive degree.

There is one paragraph of Mr. Fitzgerald's article that confuses me. In referring to the recompression theory he says that there is an argument offered against this theory that it is impossible to ignore; namely, that it is common knowledge that in compressing air, work is done on the air and consequently a certain amount of heat is developed. That is correct, or at any rate I agree with him. Work and heat are mutually convertible. Then he says that "it is equally common knowledge that in expanding, air performs a certain amount of work, and in so doing, absorbs a certain amount of heat." This is one of his points that confuses me. It has been accepted as correct for many years that steam expanding in an engine cylinder and doing work, loses, or gives up, heat, and does not absorb it. It seems to me that air should follow the same rule.

He says next that "the theory is that the compressed

air in the discharge line leaking back into the cylinder, naturally expands, and in the process of expansion becomes cooled to such an extent, etc."

This also confuses me. It has been understood for a long time by engineers that when steam passes through a reducing valve its temperature is not lowered, but it is the same as it was on the high-pressure side of the valve, less the small amount lost by radiation.

Air should follow the same rule, and if it does, its temperature when it returns to the cylinder will be the same as it was on the discharge side of the valve plus that due to heat absorbed from the frictionally heated valve.

Mr. Fitzgerald then sums up by saying that "this would seem to be perfectly possible in view of theory and formula, but the fact remains that the heated air leaking back into the cylinder does not cool to the theoretical temperature." Here he states a disagreement between theory and practice. Which is right? I believe that correct theory and practice will be in perfect harmony, therefore there must be something wrong with his theory. R. McLAREN.

Toronto, Ont., Canada.

[The work done by a gas or vapor in expanding without heat interchange with the cylinder walls is at the expense of its internal energy. Consequently, the temperature of the gas is lowered. This is undoubtedly what Mr. Fitzgerald meant when he stated that "air absorbed heat in expanding"; that is, heat was transformed into work.

In passing through a reducing valve, steam does not remain at the same temperature, but when reaching the low-pressure side it is actually lower in temperature although the total amount of heat in a pound of the steam remains constant. For this reason the low-pressure steam is drier than it was in the high-pressure side, or in case it was in a dry saturated state in the high-pressure side, becomes superheated in passing through the valves.—Editor.]

Explosions in Electric Steam Boilers

In the issue of July 22, 1924, is reported an explosion in an electric heating boiler occurring in Winnipeg, Canada. I have read the article through and am at a loss to understand why you blame the electric boiler as the cause of the explosion. Any engineer can readily see that an explosion would have occurred in any boiler installed under conditions similar to those in the Winnipeg boiler. Your editorial says: "Although explosions have occurred only with small heating boilers . . ." This presupposes frequent previous explosions in electric boilers or heaters. Permit me to say here that since electric boilers have been put on a commercial basis (about ten years ago in Europe and since then in North America) I have no knowledge that any electric boiler has exploded due to gas, as you reiterate so strongly. Again quoting your editorial: "Whenever explosions of electric boilers have occurred, the theory has been advanced that gas explosion took place in the steam around the electrodes . . ." I should be obliged to you to give me the dates and places of such explosions as have occurred due to gas.

Over 350,000 kw. of electric steam boilers and heaters have been installed in North America and I have yet to learn of the failure of one due to gas explosion. I have no hesitation in denying the theory that gases generated in electric boilers cause them to explode. Electric boilers generate no more uncondensable gases than any other steam-producing equipment. No explosions can take place where correct engineering knowledge and design are applied, a thing very much lacking in this instance.

You claim that no one has ever gone to the trouble of finding out the danger due to gas explosion in electric boilers. You are incorrect. A great many experiments have been made both in this country and Europe, and manufacturers are satisfied that they are perfectly safe when properly designed and installed.

Your report of the affair on page 152 of the issue in question does not go far enough in its explanation of the causes of the explosion. R. A. Stewart, provincial boiler inspector, from whose report you quote, is not quoted at sufficient length to form the correct opinion of the causes of the failure of this particular apparatus. A gas analysis from a similar Winnipeg electric heater was submitted to Dr. Skirron, chief chemist of the Canadian Electro Products Co. at Shawinigan Falls. He says in part: "It would be an absolute impossibility to explode this gas without mixing it with more oxygen than it contains."

The gentlemen investigating the failure of the Winnipeg boiler find no evidence of gas; that the destruction of property was due to the explosion of steam and the flashing of the water in the boiler into steam; that mechanical deficiencies were the causes of the explosion.

Electric boilers, large and small, are increasing in numbers very rapidly, and not one has failed due to explosion as suggested in your editorial. In fairness to all manufacturers of this equipment, I trust you will give this letter the same prominence as your editorial. The burden of proof of such statements as yours rests not with the manufacturers, but with the authors. FRANK HODSON, Vice-Pres.,

Philadelphia, Pa. General Furnace Co.

[The purpose of the editorial to which Mr. Hodson takes exception was to bring out some concrete facts that would either prove or disprove the gas-explosion theory as applied to electric steam boilers. As stated in the editorial, "So far as published records are concerned, there appears to be nothing authentic to show that an explosion in an electric boiler has ever occurred from such a cause." However, this theory has been advanced a number of times. Even in the Winnipeg explosion, in some of the first reports on the cause the possibilities of a gas explosion in the boiler were given considerable prominence. Until the results of tests are published that will disprove the possibility of gas explosion in an electric steam boiler, belief in such a theory will probably exist in the minds of many engineers. Even Dr. Skirron's statement, "It would be an absolute impossibility to explode this gas without mixing it with more oxygen than it contains," admits of being interpreted that gas can be formed and if its oxygen content were to be increased an explosion can occur. The results of the great many experiments, which Mr. Hodson says have been made both in this country and Europe and have satisfied manufacturers that electric steam boilers are perfectly safe when properly designed and installed, would, if made available, be one of the easiest ways of disproving the gas-explosion theory and would be welcomed by many interested in the application of the electric steam boiler. The columns of *Power* are open for the publication of the results of such experiments.—Editor.]

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Burning of Clean Heating Surface

What would cause the heating surface of a clean boiler to become burnt or blistered below the water-line carried in the boiler? *W. S. G.*

Heating surfaces are likely to become burnt if the heat is so concentrated that generation of steam drives the water away from the heating surface. From that condition the boiler material may become overheated from much slower transfer of the heat than when the water remains directly in contact with the heating surface.

Extension of Boiler-Heating Surface into Uptake

What would be the benefit of discharging boiler-feed water through a pipe coil containing 50 linear feet of 1¼-in. pipe placed in the uptake of a 72-in. by 18-ft. horizontal return-tubular boiler? *P. W. W.*

The rate of heat transfer would depend on the temperature of the gases and freedom of the heating surface from soot. A return-tubular boiler 72 in. in diameter by 18 ft. long would have about 1,600 sq.ft. of heating surface, and at best the pipe coil could not be considered as more than about 1½ per cent increase of the boiler-heating surface. Placed in the last pass of the furnace gases, the size of uptake should be enlarged to compensate for the obstruction offered by the coil. The pipe surfaces will be less efficient than the average efficiency of the boiler-heating surfaces, more especially if the coil is not kept clean of deposits of soot.

Rating at Which Specific Speed of Hydraulic Turbine Is Based

On what rating is the specific speed of a hydraulic turbine based? Is it maximum horsepower, normal rated horsepower, or the point of maximum efficiency? *F. A. A.*

It is customary to base the specific speed of a hydraulic turbine upon its rated capacity, although it is sometimes calculated on the basis of the maximum output, and occasionally at its best efficiency. It is the accepted practice now to utilize the rated output of the unit for this value. The rated output, however, is subject to some variation, depending upon the standard practice of the manufacturer in question. It has been the practice of one manufacturer, where other conditions are not considered, to specify the rated output as being 5 to 7 per cent less than the maximum output as indicated on the various tests. In other words, allow about a 6 per cent margin above the rating for the maximum output, so that in the case of a 10,000-hp. turbine this unit would deliver as a maximum output possibly 10,600 hp. The maximum efficiency of this unit might occur at any point between ¾ load and full load, depending upon the characteristic of the unit and the type of runner used. For a low-speed unit, the maximum efficiency would probably occur at approximately ¾ of the maximum output, whereas for a high-speed propeller-type runner the maximum efficiency may occur within 5 per cent of the maximum power, and thus would very nearly coincide with the so-called rating of the machine.

Resetting Slipped Eccentric

How can it be known whether the eccentric of an engine has slipped without indicating the engine or uncovering the valves? *W. N.*

It must be assumed that the eccentric rod and hook rod or valve rod are of correct length. If the previous position of the eccentric cannot be determined by the marks of the setscrew on the shaft or other marking between the shaft and eccentric, place the engine nearly on a center and turn it over to a position where admission should begin and open a little with the throttle, observing whether steam blows from an indicator cock or drip cock in the same end of the cylinder. If it does not, set the eccentric forward a little at a time, each time making the same test by opening the throttle valve a little. Then make the same test on the other end and observe whether the same amount of lead is obtained. If not, move the eccentric forward or back to correct one-half of the difference.

Suction and Discharge Pipe Sizes

What are the formulas for diameter of suction and discharge pipe for pumping a given number of Imperial gallons per minute? *W. B.*

The diameter selected depends on the loss of head from pipe friction which may be sustained when pumping a stated quantity per minute through pipes of stated lengths. The loss of head for a given pipe diameter is nearly in direct proportion to the square of the velocity or gallons pumped per minute and is directly as the length of the pipe. Under ordinary conditions a permissible loss of head in the suction pipe is not exceeded when the velocity is 240 ft. per min. and in the discharge pipe when the velocity is 300 ft. per min. These velocities require

$$\textit{Suction pipe diameter in inches} = \sqrt{0.12\,G}$$

$$\textit{Discharge pipe diameter in inches} = \sqrt{0.096G}$$

where G = Imperial gallons per minute.

For example, if the discharge is 600 Imperial gallons per minute, then for $G = 600$, the formula for the suction pipe size would be $\sqrt{0.12 \times 600} = 8.48$ in. diameter and an 8-in. pipe would be recommended. From hydraulic tables giving loss of head in pipe, it may

be found that the loss when discharging 600 Imperial gallons per minute through 100 ft. of ordinary 8-in. iron pipe would be about 2.5 ft. of the head and losses from entrance, and velocity heads would be about 0.88, or a total loss of 2.58 ft. of the head. In the same way the discharge-pipe size obtained by the formula would be $\sqrt{0.096 \times 600} = 7.59$ in. If an 8-in. pipe were used, the loss of head from friction would be about 2.5 ft. per 100 ft. length, and if a 6-in. pipe were used the loss would be about 7 ft. per 100 ft. of pipe.

Repairing Crack Around Upper Part of Chimney

We have a brick chimney with a 36x36-in. flue about seventy feet high, which shows a crack all around the outside about five feet from the top. Can the chimney be made safe by pointing up the crack and placing iron staves at the corners, or should the top be taken down and rebuilt? *J. H. B.*

The crack undoubtedly results from constructing the inside or core walls tied into the outside wall near the top of the chimney, and expansion of the core walls has raised the upper portion of the outer walls away from the lower courses of the brickwork. The upper part of the chimney can be made as safe as any other part by cleaning out the joint and driving in flat steel wedges about 8 in. centers all around at the time the core is hotter than the usual temperature when the chimney is in use. The joint then can be pointed, and with good bearings on the wedges it should not be necessary to apply corner staves and bolts excepting as an extra precaution. If the top is taken down and rebuilt, care should be taken that the core walls are independent of the side walls, if necessary, stopping off the core before it comes in contact with the battered side walls.

Determining Percentage of Moisture in Coal

How can determination be made of the percentage of moisture in coal? *E. G. R.*

The whole moisture consists of surface moisture received by wetting down the coal, exposure to the atmosphere, rain, snow or sleet and the moisture contained in the coal that has taken up from water percolating through the mine or from atmospheric precipitation or from washing water and moisture that is inherent in the coal. Obtain a fair sample by taking four or five shovelfuls from different parts of the pile and thoroughly mix.

Where a large drying oven is available, the total of the moisture can be determined by heating several pounds of the coal sample in a glass jar or other vessel with the cover removed, at a temperature between 240 and 280 deg. F. until the minimum weight is reached. Then the percentage of moisture is the loss of weight multiplied by 100 and divided by the original weight of coal.

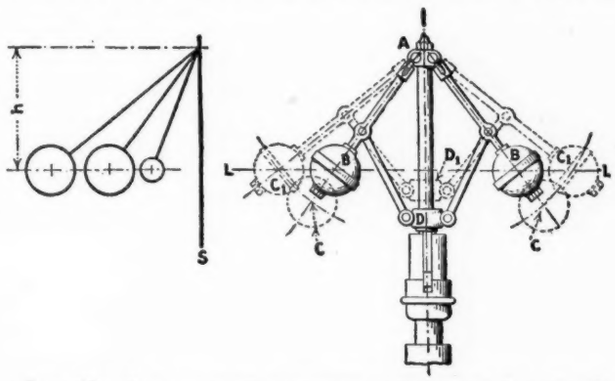
To determine separately the surface moisture and moisture contained in the coal, take about four pounds, weighed in a scale sensitive within one-quarter of an ounce or at least within one per cent of the weight of the sample. Spread the sample in a thin layer on a clean pan and expose it for several hours to the atmosphere of a warm room and take the difference of weight before and after drying. The loss of weight multiplied by 100 and divided by the original weight gives the percentage of surface moisture.

Then crush the whole of the coal by running it through an ordinary coffee mill to produce grains somewhat courser than $\frac{1}{16}$ in. Thoroughly mix the crushed sample, select from it a portion of from 10 to 50 grams, weigh in a balance and dry it for one hour in an air or sand bath at a temperature between 240 and 280 deg. F. Then weigh the sample and record the loss. Heat and weigh again until the minimum weight has been reached. The difference between the original and the minimum weight, multiplied by 100 and divided by the product of the original weight multiplied by 1 minus the fraction of surface moisture, gives the percentage of moisture of the original coal which was not removed as surface moisture. This added to the percentage of surface moisture gives the total percentage of moisture.

Lengthening Arms of Pendulum Governor Reduces Engine Speed

If an engine is provided with a pendulum type of governor, neglecting the weight or resistance at the center, what effect would it have on the engine speed if the governor balls are provided with longer arms? *M. B.*

Neglecting any resistance from friction or from weight or other resistance to the movement of the collar up or down on the spindle, and assuming all weight to



Lengthening arms of governor reduces engine speed

be concentrated at the center of the governor balls, for a given speed, the weight of ball and length of arm have no effect on the height assumed by the balls. As illustrated in Fig. 1, several governors revolving about one spindle *S* would all stand at the same height *h* when turning the same number of revolutions per minute, although they had different lengths of arms and different weights of balls.

Hence, if the governor balls *BB*, Fig. 2, with arms *AB* are brought to the level *LL* for a given number of revolutions, then by moving them to the dotted positions *C* with length of arm *AC*, for the same speed they would be brought to the same level *LL*. Since from rising to the position C_1C_1 there would be movement of the collar *D* to a position D_1, that would result in shorter cutoff and the speed of the engine would be reduced. If the load on the engine is balanced with the cutoff that is obtained when the collar is in the position *D*, the corresponding supply of steam would be obtained with the balls in position *C*, which position would be satisfied by a slower speed than the speed necessary to obtain the same position *D* with the length of arms *AB*. Consequently, lengthening the arms of the governor balls will cause the engine to be governed to a slower speed.

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

Tapping the Earth's Heat

IT IS well known that there are various sources of "free" energy such as waterfalls, the wind, tides, the sun's heat and the heat stored in the earth's interior. Of all these the energy of falling water (not counting the waves and the tides) is the least abundant, yet more use has been made of it than of any of the others. There are a few successful tide mills. Windmills are widely used on farms, yet the total power generated in this manner is not very great. The earth's heat is used for power generation only in a few favored spots where natural hot water or steam is available at or near the surface. Practically speaking, all these sources of energy remain untapped.

The non-utilization of these enormous stores of energy has led some laymen to feel that engineers are asleep at the switch, but the engineer knows that the idea of "free" power is a delusion. The tide may be free in the sea and the wind in the air, but their translation into electricity at the customer's home or mill involves a huge expense for overhead charges on investment in machinery, dams, windmills energy-storage devices, transmission lines, etc.

It is this hard fact that has, so far, practically prevented the use of wind power, wave power, tidal power and the earth's heat. Generally, such plants require an enormously higher investment than steam or ordinary hydro-electric plants.

Sir Charles Parsons Proposes 12-Mile Shaft

These preliminary observations bring us to the case in hand, which is the question of tapping the earth's heat to produce steam for power generation. No less a figure in the engineering world than Sir Charles Parsons, inventor of the steam turbine, has recently repeated his old proposal to sink a shaft 20 ft. in diameter and 12 miles deep.

In fairness to Sir Charles it should be said that he suggests this not as a commercial proposition, but as a great scientific experiment with much of the sporting element that prompts men to seek the North Pole. Geologists have great need for first-hand information regarding the structure of the earth's crust, and it is not inconceivable that this information might be worth the odd $25,000,000 Sir Charles hopes to induce the multi-millionaires to sink in the project.

The purpose of the present article is to discuss the feasibility of such a shaft for power generation alone. If the verdict is adverse, it does not imply condemnation of the project as a scientific experiment, provided it seems worth while to the geologists whose science it is to advance.

First, as to the cost, one guess is as good as another. The first mile might conceivably be sunk for a million dollars complete with its granite lining. The second mile would cost more, the third still more and so on. A moment's thought will show that this must be so. Take the item of hoisting. The excavated material from the first mile must be hoisted an average distance of one-half mile. For the second mile the average hoist is one and one-half miles, for the third two and one-half, etc. The travel of the workers to and from the point of excavation increases correspondingly.

Would Encounter Great Difficulties

The hoisting would have to be done in relays of not more than a mile in length. A cable of one square inch cross-section weighs about 18,000 lb. per mile. Thus, with no car or load the cable tension at the top would be 18,000 lb. per sq. in. for a one-mile lift, 36,000 lb. for a two-mile lift and so on.

Again, the pressure of the atmosphere would increase markedly as the bottom of the shaft was approached. This, however, would not be an insuperable difficulty, as caisson gangs already work under fairly high pressures for short periods.

Increasing temperatures would be a much more serious obstacle. The deepest mine shafts now in existence are something over a mile in depth. From measurements in these it may be expected that the temperature will increase at the rate of about 100 deg. per mile for the first few miles, although the actual rate varies greatly in different localities. Whether the original rate would be maintained is a debatable question. The best geological opinion seems to be that the increase would become much slower after the first three or four miles had been passed.

Whether the final temperature is high or low, trouble may be expected. If the temperature does not exceed, say, 400 deg. at the bottom of the twelve-mile hole, it seems that only a small amount of steam could be produced and that at a low pressure. If, on the other hand, the temperature is of the order of 1,000 deg., it is hard to conceive how any mechanical devices could keep the workers alive even if the enormous pressure did not cave in the softened lower extremity of the shaft. So it is questionable whether $25,000,000 or any sum of money could carry the shaft down to a temperature of 1,000 degrees.

Let us assume that the attainable temperature is 600 deg., this temperature to be reached at a depth of 12 miles and a cost of $25,000,000. Rock is a poor conductor of heat. If a large reservoir were excavated at the base of the shaft and supplied with a million or two pounds of water per hour for steam generation, it is not probable that the steam temperature (saturated) would exceed 400 deg., corresponding to 247 lb. per sq.in. absolute pressure.

The steam pressure at the top of the shaft would be much less than this for two reasons: First, there would be a considerable pressure drop due to the flow in a main twelve miles long, even if it were made large enough to give a low steam velocity; secondly, the weight of a column of steam of this height would be considerable and would result in a steady decrease in pressure from the bottom to the top. In this connection the accompanying table is of interest, showing the pressure at all levels in a column of dry saturated steam 12 miles deep with a pressure of 247 lb. absolute at the bottom.

PRESSURE IN A STATIONARY COLUMN OF SATURATED STEAM

Depth, Miles	Pressure, Lb. per Sq. In., Absolute
0	93
1	101
2	110
3	120
4	130
5	140
6	153
7	166
8	180
9	195
10	211
11	228
12	247

This table assumes no motion and dry saturated steam at each level. With motion there would be not only a considerable friction drop, but an additional pressure drop due to the weight of the moisture formed in the rising and expanding steam. It is therefore evident that the turbines would do most of their work in the vacuum range.

Might Pay as Scientific Experiment

Assuming that, for the investment to pay, it would be necessary to develop one kilowatt for each $250 of investment (not counting surface investment in turbines and generating equipment), the shaft would have to develop 100,000 kw. With a steam consumption of 20 lb. per kilowatt-hour, this would require 2,000,000 lb. of steam per hour. In the absence of data on the flow of heat through rock this would appear to require a prohibitive amount of "heating surface."

While the prospects of getting cheap power from such a source are far from rosy, the satisfaction of human curiosity and the advancement of scientific knowledge may conceivably warrant an attempt to sink such a shaft as that proposed by Sir Charles Parsons.

New and Improved Equipment

New Applications of the Mercon Valve

In the Oct. 16, 1923, issue of *Power* a description was given of the Mercon pump regulator as manufactured by D. H. Skeen Co., 407 South Dearborn St., Chicago. This regulator employed the pressure of a mercury column in the place of the usual spring or weight in a regulating valve, thereby eliminating stuffing boxes and packing.

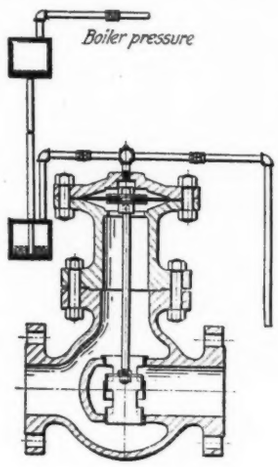


Fig. 1—Differential governor for motor-driven pump

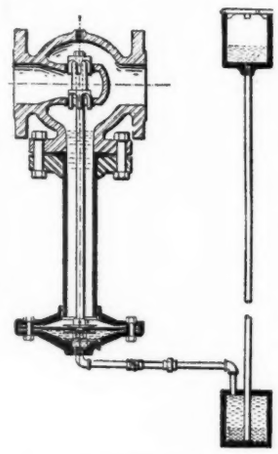


Fig. 2—Constant-pressure regulator or reducing valve

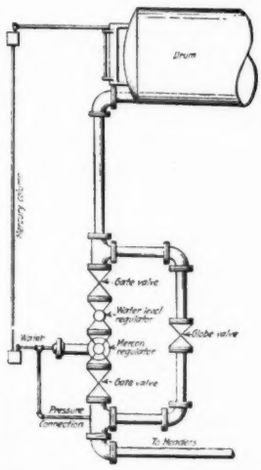


Fig. 3—Constant-flow regulator for boiler feeding

A thin rubber diaphragm with a balanced pressure on both sides is employed, and this diaphragm is kept cool by a water leg extending below the valve proper. Since the publication of this article a number of other applications of the same principle have been developed and put into service.

For boiler-feed service on turbine-driven pumps, the equipment is essentially the same as previously described except that a throughbolted bonnet-type body replaces the older construction and two mercury pots are used instead of one, to obviate the necessity of keeping a large number of joints tight when the system is filled with mercury and to enable the placing of the mercury column in any location either above or below the governor.

Fig. 1 illustrates the use of the same principle for giving a constant differential above the boiler pressure where the boiler-feed pump is motor driven and its speed constant. In this case the governor is put on the pump discharge and automatically throttles to maintain the differential desired. It is simply a water-reducing valve, but instead of reducing to a constant pressure, the pressure is variable, being the sum of the boiler pressure plus the pressure of the mercury column, of which 2 inches is equivalent to one pound.

Fig. 2 shows the regulator adapted as a constant-pressure regulator or reducing valve. In this instance the inlet of the valve is reversed and the low pressure or the pressure to be controlled, is in communication with the diaphragm. The pressure of the mercury column has to be, in this case, that of the low pressure to be maintained.

The objection to controlling boiler-feed pressure at the pump is that the friction head between the pump and the boiler is variable, depending on the amount of flow. One of the largest stations now under construction will use an individual valve on each boiler as shown diagrammatically in Fig. 3, to insure a constant flow for boiler feeding. The valve used is the same as that used for throttling the discharge of a motor-driven pump shown in Fig. 1.

Other uses for the Mercon valve are as a constant-flow regulator and as a constant-back-pressure valve. In the latter valve, the higher pressure acting on the diaphragm is balanced by a mercury column.

Straight-Line Two-Stage Compressor

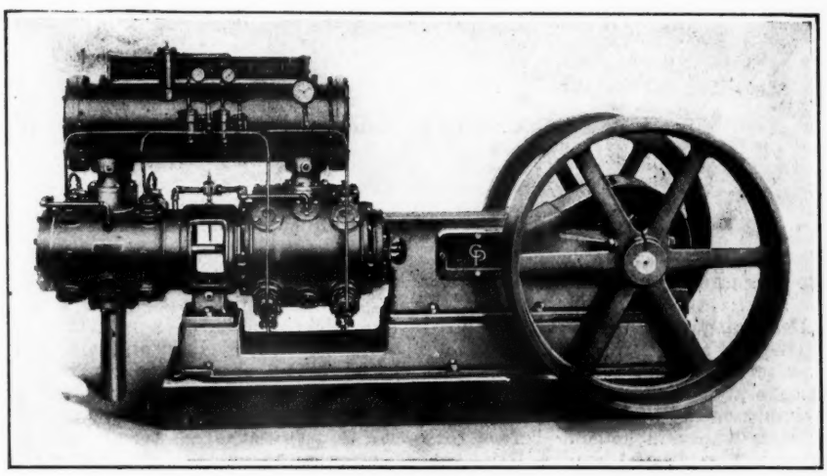
The Chicago Pneumatic Tool Company has developed a straight-line two stage belt- or motor-driven compound air compressor, designated as Class N-CTB, for pressures up to 125 lb. Operating at 275 r.p.m., this compressor has a piston displacement of 360 cu.ft. of free air per minute.

Tandem construction is used in this unit, in which the low-pressure cylinder is placed next to the frame and the high-pressure cylinder is connected to the low-pressure cylinder by means of a tandem piece through which the piston-rod stuffing boxes are easily accessible. The intercooler is conveniently mounted above the two cylinders.

The splash-and-flood system of lubrication is employed for all bearings, while the cylinders may be lubricated by any standard sight-feed lubricator, by a pneumatically operated force-feed lubricator, or by a mechanically driven force-feed lubricator.

Regulation of the volume of air and its pressure is entirely automatic and can be furnished to conform to the special conditions of the demand for air. Three-step capacity regulation is regularly furnished, in which two differential unloaders operating automatic-unloading Simplate inlet valves cause the compressor to operate at full, half and no load according to the air demand.

When the air demand is fairly constant for periods in the day with intervening periods in which there is slight or no demand for air, and the compressor is driven by an electric motor, automatic start and stop control operation can be employed. In this case the unit is equipped with a centrifugal unloader which causes the automatic-unloading inlet valves to be held open during the period in which the compressor is at a standstill and



Chicago Pneumatic Tool Compound Air Compressor

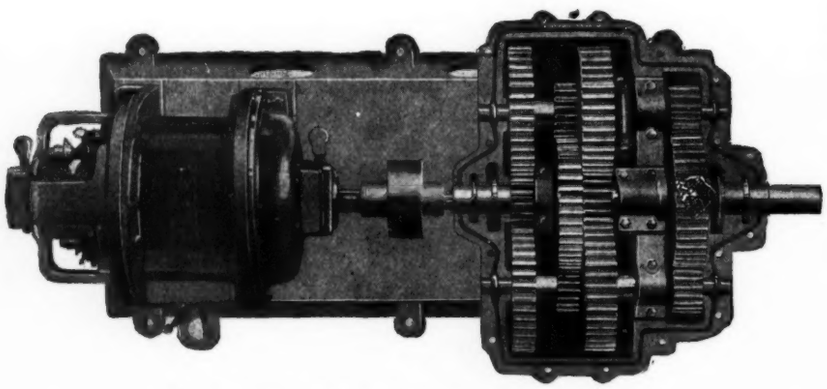
to remain open until, in starting again, the compressor has nearly reached normal speed, when the valves are again allowed to operate. During slowing down prior to stopping, the unloader comes into action and throws the load off the compressor, thereby eliminating much objectionable slapping of the belt in the case of a belt-driven unit.

Automatic operation of the unit is effected through the use of a water-control valve, which automatically stops the flow of cooling water through the jackets and intercooler during periods in which the compressor is at a standstill, and allows it to flow when the compressor is in operation.

Huron Speed Reducer

In the illustration is shown the new spur-gear speed reducer built by Huron Industries, Inc., of Alpena, Mich. To inclose the gears, a semi-steel housing is employed, the cover being bolted to the lower housing with the joint surface machined and grooved to prevent loss of oil. Cut steel gears with bronze bushings and bearings are used, and full bearing support is obtained through the introduction of a bridge wall cast integral with the lower housing.

Within this bridge wall is an oil compression reservoir forming part of the force-feed system of lubrication featuring the reducer. By a single-cylinder plunger pump driven from an eccentric on the slow-speed shaft, the oil is drawn from the casing and at about 4 lb. pressure is forced into the reservoir. The pressure maintained on the reservoir is sufficient to force the oil to the main bearings, where it enters the hollow shafting of the gears through radial openings and through other radial openings at all bearings is transmitted directly to the wearing surfaces. Any overflow returns to the casing. For the main bearings in the casing ring oilers also are employed and there



Huron speed reducer with housing cover removed

are oil guards to prevent seepage along the shaft.

Depending upon the service required of the reducer, a thrust bearing may be inserted on the driven shaft. It is incorporated within the casing, and by distributing the thrust stresses into the bearing wall and housing before they reach the gears and bearings, the performance, alignment and longevity of the reducer are improved.

The Refractory Gun

A comparatively light portable outfit for the coating of furnace walls, designed by the H. M. Thompson Co., Inc., 9 South Clinton St., Chicago, is shown in the accompanying illustration.

The equipment consists of a lead-lined steel drawn tank made in capacities of 9, 12 and 25 gal., resting on a base with one wheel for the smaller size and two wheels for the larger size; a refractory gun, which is about the size of an automatic revolver, and the interconnecting fluid hose and the air line. The tank and all may be taken into the furnace where door openings are 16 in. square.

The batter is made up of 30 per cent Hytempite diluted with water and 70 per cent firebrick crushed to 16-mesh. These materials are mixed to a heavy cream consistency and run through an ¼-in. screen into the tank. With this mixture clogging at the gun nozzle is eliminated.

For the operation of these units it is necessary to have at least 14 cu.ft. of free air per minute at a pressure of about 100 lb. Depending entirely upon the consistency of the material used, air pressures ranging from 5 to 25 lb. are required to elevate the mixture from the container through the material supply hose to the gun, where air at a pressure of 75 to 100 lb. mixes with the material and drives it against the furnace walls.

As will be apparent from the illustration, the entrance for the air is at the back of the gun, while the material hose is connected to the bottom of the gun, underneath the fluid valve assembly. This valve has an opening large enough to pass the material previously specified, and it is arranged on an angle so that as the material is forced by the pressure in the tank into the opening, the air pressure meets the material at this point and forces it onto the surface to be coated in a spray instead of driving it out of the nozzle in a straight line. Three sizes of nozzles are provided for fine, medium and coarse material. The one trigger of the gun controls both the air supply and the fluid valve and is so constructed that the first pressure admits air and further pressure on the trigger opens the material valve. In the same manner, when stopping the operation, the material valve is closed first and the air valve last, thus blowing out any material that may have been left in the gun.

To regulate the air pressures, control valves are provided. There is also an agitating valve through which air is admitted into a small pipe leading to the bottom of the tank, to agitate the material and keep it in solution when needed. Gages show the pressures employed. A safety valve is provided to guard against excessive pressure in the tank and, in addition,

Complete Assembly of Refractory Gun Outfit

a butterfly valve, which may be opened when blowing the material back out of the hose into the tank, to keep the air pressure from building up higher than is necessary to lift the material up to the gun. This operation is necessary only when the material in the tank is running low and it is desirable to clean out the hose before stopping for refilling with a fresh batter. The control gages and valves mentioned are all placed on the cover of the tank.

It is claimed that one of these guns will apply a coating ⅛ in. thick to a surface of 100 sq.ft. in eight minutes at a cost of $1.17.

The Bridgeport Engineering Institute, which is endorsed by the A.S.M.E., will open up for the first time at the Bridgeport, Conn., High School, Oct. 13. It will provide a four-year course of instruction in engineering subjects at a nominal cost to men of the local industries who are employed during the day. At a recent meeting of the newly formed Institute, W. R. Webster, vice-president of the Bridgeport Brass Co. and president of the American Tube & Stamping Co., was elected president for the coming year. A. E. Keating, plant engineer of the American Tube & Stamping Co., will be the dean of the Institute and the other members of the board elected were: Stanley Bullard, the Bullard Machine Tool Co.; Walter R. Clark, general works manager of the Bridgeport Brass Co.; and W. S. Clark, general manager of the Bridgeport plant of the General Electric Co.

Low-Temperature Carbonization*

By Dr. C. H. Lander†

ALTHOUGH the question of the low-temperature carbonization of coal has been before the public for almost twenty years, it cannot be claimed that a complete solution of the many problems involved has yet been obtained. The degree of success depends upon the point of view, the use of so-called waste fuels being a simpler problem than that of carbonizing and selling at a profit coal of such quality as to command a price commensurate with that which the public would be willing to pay for the smokeless fuel produced.

The aims of the early plans were to obtain a smokeless fuel for domestic uses, and thus alleviate the smoke nuisance in the large towns. In 1913 low-temperature carbonization was recognized by the Royal Commission on Fuel and Engines for the Navy as affording a promising method of providing a home-produced fuel oil suitable for use by the Navy and the merchant marine. As only 6 or 7 per cent of the weight of coal treated appears as oil, it would evidently be necessary to find a market for the other products in order to render the proposition an economic one. Thus the problem is of national significance.

The war brought home the need more sharply. Therefore (in 1917) a board was established for the promotion and co-ordination of research on fuel problems.

Economic Difficulties

Owing to the changes that have resulted from the war, the economic solution of the problem has proved much more difficult than was at first anticipated. Much progress has been made toward a technical solution, and the elements of uncertainty still remaining are mainly those of an economic nature.

The gas industry at present aims to develop as much as possible of the potential heat of the raw coal in the form of gas. In the future this industry will doubtless give more attention to the possibility of becoming the largest supplier of forms of fuel other than gas. Among these may be mentioned coke for household use.

The gas industry is also watching the development of low-temperature carbonization from the point of view of the possibility of utilizing the rich gas from carbonization at 1,100 deg. F. as an agent for enriching low-grade gas. The calorific value of "low-temperature" gas is about 1,000 B.t.u. per cubic foot. Its high concentration would lower the cost of storage.

The amount of oil obtainable varies with the coal used and the process adopted. In experiments with horizontal externally heated steel retorts the Fuel Research Board obtained yields of dry oil varying from 13 to 20 gal. per ton. Fifteen gallons per ton might be taken as a fair average.

The oil obtained differs considerably in composition from natural oil and, in addition to its fuel uses, is valuable for the manufacture of disinfectants and preservative paints. Several groups experimenting with low-temperature carbonization have had no difficulty in selling this oil at three times the price of foreign fuel oil. However, this enhanced price would not be likely to continue after the industry was established on a large scale. At the present time it is not safe to assume a stable value exceeding 5 pence (about 9 cents) per gallon.

Ability to mix with natural fuel oils is important for naval use. Tests were made on seven oils. Two of these (American and shale oils) would not mix at all with the crude low-temperature oil. Stable mixtures with Burmese, Texas and Mexican oils were obtained only with less than 25 per cent of low-temperature oil. With Trinidad oil only, was complete miscibility obtained, and even then the application of heat was necessary. This disability is, however, being overcome by several processes that are being experimented upon at the same time, and the difficulty can also be surmounted by fractionating the oil.

Light distillates can be produced for use in oil engines, from 1.0 to 1.6 gal. of spirits being obtainable per ton of coal. This will mix with gasoline and benzol in all proportions.

The possibility of establishing a low-temperature carbonization industry on a national scale depends largely upon the recognition by consumers of the superiority of smokeless fuel over raw coal as fuel. This appreciation must take the form of willingness of domestic consumers to pay a higher price.

The yield of coke per ton of coal by straight low-temperature carbonization amounts to about 1,400 lb. on the average. It has been assumed in the computations that have been made in the past that the price obtainable for the coke will be sufficient to meet the entire cost of the coal used. The possibility should not be neglected, however, that the smokeless fuel may only command a price equivalent to that of raw coal, weight for weight. It will be seen, therefore, that in the latter case the price obtainable for the liquid and gaseous products of carbonization must be sufficient to yield a profit after paying the cost of about 600 lb. out of every ton of the raw coal treated, together with the entire cost of retorting.

Overestimating the Byproducts

Extravagant credits are often taken for the ammonia produced in low-temperature carbonization. In view of the small possible yield at the low prices obtainable, it is hardly worth while taking the ammonia into consideration in the balance sheet of a straight low-temperature process.

The processes of low-temperature carbonization may be broadly and roughly classified into those using *external* heating of a gas-tight retort, and those in which some substance such as producer gas, superheated steam, "low-temperature" coal gas, melted lead or hot sand is used for *internal* heating.

Many subdivisions are possible. The coal may be in repose during the process or turned over by blades. The latter shortens the time.

With the tight-retort process the products per ton of coal will run about 3,000 to 3,500 cu.ft. of gas of 900 to 1,000 B.t.u. per cubic foot and 12 to 17 gal. of crude oil. The fusible constituents must lie between certain limits if a coke suitable for domestic use is to be produced. In certain cases suitable results are obtained by mixing two coals.

The "internal heating" process, using producer gas, results in a much larger volume of gas of lower heating value. The commercial success of the process, therefore, depends very largely upon securing a profitable outlet for low-grade gas. The method is exceedingly interesting on account of its low capital cost. A most interesting development in this connection arises from the decision of the Glasgow Corporation to install a battery of five units of Maclaurin producers at Dalmarnock. Two objectives are aimed at: First, the production of smokeless fuel, and second, to prove whether or not the gas obtained by the process can be economically used for the firing of the boilers in the generating station.

*Abstract of paper presented at World Power Conference in Wembley, England.

†Director of Fuel Research under the Department of Scientific and Industrial Research (Great Britain).

Submerged Coil Evaporators in the Navy

Some time ago it became the general policy of the Navy Department to equip all naval vessels with low-pressure evaporating plants. There were several reasons for this, the first of which was the large amount of exhaust steam available on shipboard. Another reason was a reduction in the scaling as compared with high-pressure evaporators. At the present time all new vessels of the Navy are being equipped with low-pressure evaporators of the film type. According to Lieutenant Ellsberg, U.S.N., writing in the August, 1924, issue of the "Journal of the American Society of Naval Engineers," operations can be simplified and improved by submerging the tubes of the low-pressure evaporators. The writer bases this statement upon experiments made by him on several U. S. ships.

According to Lieutenant Ellsberg the submerged-tube low-pressure evaporator will have the following advantages over the film type: The cost of installation will be reduced by the elimination of circulating pumps and motors, suction piping and discharge piping for the circulating systems, sump tanks and strainers, automatic feed regulators, feed-strainer baskets, distribution plates, and the special film-type coils. The cost of operation will likewise be reduced on account of fewer auxiliaries and a reduced personnel. Reduction in the number of auxiliaries will also, according to the writer, increase the reliability. Finally, it is claimed that submergence of the coils in low-pressure evaporators almost entirely eliminates scaling. Other advantages claimed are increased capacity, purer distillate and somewhat higher thermal efficiency.

Grenoble To Have Water-Power Exhibition

Grenoble, France, has been having a series of fêtes in honor of "white coal," as it was in Grenoble that the first French hydro plant was installed in 1867. The corner stone of the building for the International Water-Power Exhibition, which is to be held next year from May to October has recently been laid France has during the last ten years been developing her water power, in spite of war, to the extent that the utilization of power has risen from 750,000 hp. to over 2,000,000 hp., and it will rise in the future with equal rapidity. The Minister of Public Works and the Minister of Commerce are both encouraging the development of hydro-electric projects.

Station on Big Sioux River Being Built

The Sioux City Gas & Electric Co. is building a new station on the Big Sioux River, which will be called the Big Sioux Station. This will consist of two 10,000-kw. turbo-generators arranged with a two-point bleed-regenerative cycle. There will be included in the initial installation three 1,120-sq.ft. water-tube boilers and economizers with 30 per cent of the boiler surface. Coal will be burned in the pulverized form, and the pulverizing equipment will consist of three driers, three mills and the necessary feeders and burners. The condensers serving the generating units will be of the radial-flow type, each containing 20,000 sq.ft. of surface.

Piney Hydro-Electric Plant in Service

The Piney hydro-electric plant of the Clarion River Power Co., at Piney, on the Clarion River, Pa., has been recently put into operation.

This plant will have a ultimate capacity of 44,000 hp. At present two 11,000-hp. Westinghouse generators have been installed and are supplying light and power to Johnstown and with the prospect of serving Erie in the near future. The dam and the actual construction work on the project were done by the Charles B. Hawley Co., of New York, in conjunction with the Pennsylvania Public Service Corp. which has now assumed control of the plant.

One of the expected results of the Piney development is the electrification of the Pennsylvania Railroad from Johnstown to Altoona. The problem of electrifying the Pennsylvania Railroad is now being studied, and if thought wise the power from the Piney plant may be utilized.

Withdraw Raquette River Regulation Application

The abandonment of ten years of persistent effort by power interests and others to acquire a foothold in the heart of the Adirondack Forest Preserve, involving millions of dollars, according to the Saranac Lake Chamber of Commerce, was reached several days ago when the following interests withdrew from the State Water Control Commission their application made under the so-called Machold Water Storage law for the creation of a Racquette River Regulating District:

International Paper Co., St. Regis Paper Co., Snell Power Co., St. Lawrence Transmission Co., the Hannawa Falls Water Power Co., Village of Potsdam, Potsdam Electric Light & Power Co., Village of Norwood, N. Y.; Raquette River Paper Co., Village of Massena, N. Y.; Hanna Paper Corp. and Sherman Lumber Co.

In the campaign against the application, carried on for the last year by various North Country organizations, it was alleged that the increased value of primary water rights, had the application been granted, would have accrued to power interests without recompense to the State and that there was no public necessity shown.

Five Mid-West Power Companies Merge

One of the largest public utility consolidations of the year has been effected with the merger of interests serving nine of the Middle West states. The companies concerned in the merger serve a population of about 1,750,000 with electric light, power and gas. They are: United Light & Power Co.; Continental Gas & Electric Corp.; Columbus Railway, Power & Light Co.; Kansas City Power & Light Co. and the Lincoln Gas & Electric Light Co., with their affiliated companies.

The United Light & Power Co., with which the Continental Gas & Electric Corp. and other companies will be consolidated, has recently acquired more than 75 per cent of outstanding common capital stock of the Continental company.

The United Light & Power is the owner of important properties in Iowa, Illinois, Indiana, Michigan and Tennessee. Gross earnings have increased from less than $6,000,000 in 1912 to more than $12,500,000 this year. The combined properties are equipped with electric-steam generating stations of the most modern type, having an aggregate installed normal capacity of 340,000 kw. The gas properties output is more than three billion cu.ft. per year. The total gross revenues of the consolidation situation are about $34,000,000 a year.

Oil-Engine Companies Combine

Announcement has recently been made of the merger of the Enterprise Engine Co., of San Francisco, with the Western Machinery Corp., of Los Angeles, which brings together two of the largest builders of internal-combustion engines on the Pacific Coast and creates an organization having facilities for engineering, manufacturing and distributing adequate for the Western part of the country.

There will be no change in policy or personnel, according to press reports, by reason of the merger. The headquarters of the company will be in Los Angeles, with W. J. Donlon in charge. All Diesel-engine business will be directed from the present Enterprise plant at Eighteenth and Alabama Sts., San Francisco, with J. P. Browner, sales engineer of the Western Machinery Co., conducting the Western machinery business.

Study To Be Made of the Patent Office

That leading patent bar associations of the country are nominating members to serve on a committee to simplify the methods of procedure and expedite the business of the Patent Office has been announced by the Secretary of the Interior. Arrangements have been completed to call a meeting of these delegates at Washington in the near future to make a thorough review of the Patent Office and to submit suggestions necessary for changes in practices that will result in bringing the work of the bureau to a current basis and maintaining it in that condition.

Because of the tremendous increase in its business, the bureau has not been able to keep up with the applications for patents that have been filed by the public. Included in the committee are representatives of the National Chamber of Commerce and a number of large manufacturing concerns, who are constantly presenting applications for new patents to safeguard their business. The personnel of the committee as announced, is: George A. Prevost, representing the American Patent Law Association; Thomas Ewing, representing the New York Patent Laws Association; Henry M. Huxley, representing the Chicago Patent Law Association; Harry Frease, representing the Cleveland Patent Laws Association; Milton Tibbetts, representing the Michigan Patent Laws Association; Jo. Bailey Brown, representing the Pittsburgh Patent Laws Association; A. J. Brousseau, automobile manufacturer, representing the Chamber of Commerce of the United States.

Large Hydro Plant Planned for Indiana

A large hydro-electric plant on the St. Joseph River near Bristol, Ind., is in contemplation by the Interstate Public Service Co., in addition to its projected plants on the Elkhart. The plans for the Bristol plant are said to be for a capacity larger than the combined rating of the other plants existing or designed for the Goshen district.

Power Commission Keeps Information Inviolate

A complaint recently was raised by a large power company when it was denied full information as to the engineering plans of a small interest which had filed a conflicting application. It is the policy of the Commission to consider as confidential the detailed maps and plans covering the proposed development of projects. This applies as well to the information furnished it by the applicant as to its financial ability to carry the work forward. The general plan of each proposed development is placed at the disposal of any caller desiring that information. In the case of this particular complaint the company took a different view of the matter when it was asked if it would be willing to allow a certain interest access to its costly engineering study which had been filed in connection with an application.

Pan-American Congress To Be Held at End of Year

The Third Pan-American Scientific Congress which is to be held in Lima, Peru, from Dec. 20 to Jan. 5, will have representatives of the various branches of science from the United States government as official delegates. A. W. Whitney, chairman of the American Engineering Standards Committee, New York City, will be the United States representative for the engineering section.

These scientific congresses have been given from time to time, the first one being held at Buenos Aires in 1898 by the Argentine Scientific Society under the name of Latin-American Scientific Congress. Two other Latin-American Congresses were held, one at Montevideo in 1901, and the other at Rio de Janeiro in 1905. The United States was invited to participate in the Fourth Congress, which thus became the First Pan-American Congress, which was held at Santiago, Chile, in 1908-09. The Second Pan-American Scientific Congress was held at Washington from Dec. 27, 1915, to Jan. 8, 1916, and was participated in by delegates from all the American Republics. Over 1,000 scientists or specialists attended.

The organization of the Congress at Lima has requested that Dr. Leo S. Rowe, president of the American Academy of Political and Social Science, serve as chairman of the co-operating committees. Dr. Rowe will be glad to transmit any papers to the Secretary General of the Congress, but such papers should be received by him not later than Nov. 1. The title of the paper and possibly an abstract should be sent as soon as possible before that date.

Bituminous Coal Production Shows Improvement

Substantial improvement continues to mark the production of soft coal, according to the Geological Survey. The total output for the week ended Sept. 20 is now estimated at 9,902,000 net tons, an increase of 373,000 tons, or nearly 4 per cent. This estimate is based on the 183,426 cars reported loaded by the railroads and includes allowances for coal coked, mine fuel and local sales.

The upward movement that has prevailed since early August has carried production to the highest level reached since the first week of March. The average daily rate of output is now well above that at the corresponding date of 1921 and is but slightly below that of the weeks immediately following the strike of 1922. It is still considerably below the rate in 1920 and 1923, years of industrial activity.

Chamber of Commerce Seeks Trade Statistics Decision

In an effort to secure an official ruling to clearly define the legal rights of trade associations in collecting and distributing statistics and other activities, a committee representing the Chamber of Commerce of the United States visited Attorney General Stone, Secretary of Commerce Hoover and members of the Federal Trade Commission in Washington, Sept. 22.

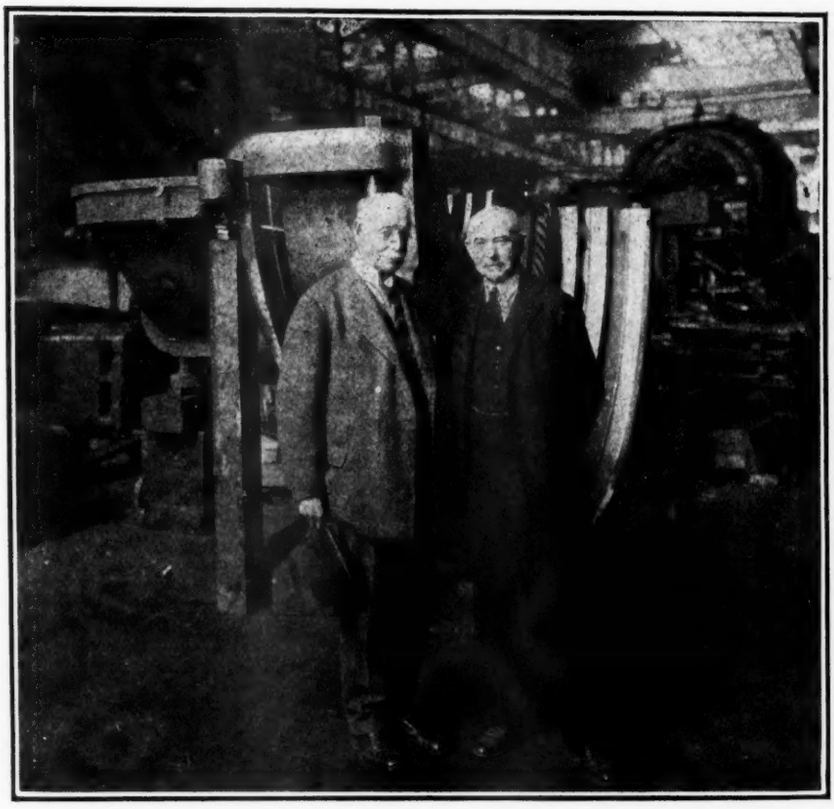
The results of a referendum undertaken by the National chamber last year on trade-association functions, together with supporting and explanatory data, were laid before the federal officials. No effort was made to secure an expression of opinion from the officials at the meetings Sept. 22, but they were asked to study the data presented them and to meet the Chamber's committee again late in October, at which time it is hoped by the committee that there may be obtained an opinion that may be made public in order to determine uncertainties which now exist.

Engine Installed in Short Time at Sidney

The fine record in the dismantling and installation of the new engine at the blooming mill of the Dominion Iron and Steel Co., Ltd., Sydney, N. S., is worthy of note.

On August 14 at 6:30 a.m. the mill stopped rolling. The dismantling of the old engine commenced at 7 o'clock. By 8:15 that evening the foundation was cleared and the engine completely dismantled, having occupied but 13 hours and 15 minutes. On Sept. 4 the first shipment of the new engine was received at Sydney; the last shipment arrived on the evening of the 8th. By 2 p.m. on Sept. 14 the engine had been completely installed and given a trial turnover, within a total of 9 days and 18 hours after its receipt.

The engine, rated at 7,250 hp. and having 21 per cent more power than the old one, was from the Lackawanna plant of the Bethlehem Steel Co. It, with a complete set of spare parts including an extra crankshaft and extra cylinders, weighed about 700 tons and required 14 cars for shipment. The engine itself weighed about 500 tons.



Sir Charles Parsons and E. W. Rice, Jr., at G. E. Schenectady plant

Progress Reported on Ottawa River Plant

Officials of the Ottawa (Canada) electric companies report unusual progress on the plant being built at Calumet Falls, Bryson, Quebec, on the Ottawa River. Two-thirds of the permanent dam has been completed, and excellent progress is being made with the power house. It is expected that by Jan. 1 the first unit will be ready and power delivered in Ottawa. The generators will be supplied by the Canadian Westinghouse Co., of Hamilton, Ontario. The Ottawa Light, Heat & Power Co. and the Ottawa Electric Railway Co. will be among the first companies to receive power from the new plant, which will develop 75,000 hp.

Long Beach Plant of Southern California Edison Co.

In October, 1923, the Southern California Edison Co. began work on the new 100,000-kw. steam plant at Long Beach. Because of the urgent need of additional current, this project was put on an emergency basis. Today, over a thousand men are at work on the construction end of the plant.

Two thousand carloads of materials have been used, and 1,000 carloads will be required in addition, to complete the power plant. The rapid progress that has been made in construction work is illustrated in the photograph shown.

In preparing the foundation, seven thousand piles averaging 45 ft. in length were driven into the sand. Upon these piles rests a "mat" of concrete 200 ft. long, 75 ft. wide, and 7 ft. thick. This mat supports the massive concrete pillars that form the foundation of the steel structure, in which 2,000 tons of steel will be used.

It was originally planned to place the first 35,000-kw. steam-turbine unit in operation next February. As a result of a rush shipment of 21 carloads of electrical equipment from the General Electric Co., current will be delivered on the lines during November of this year.

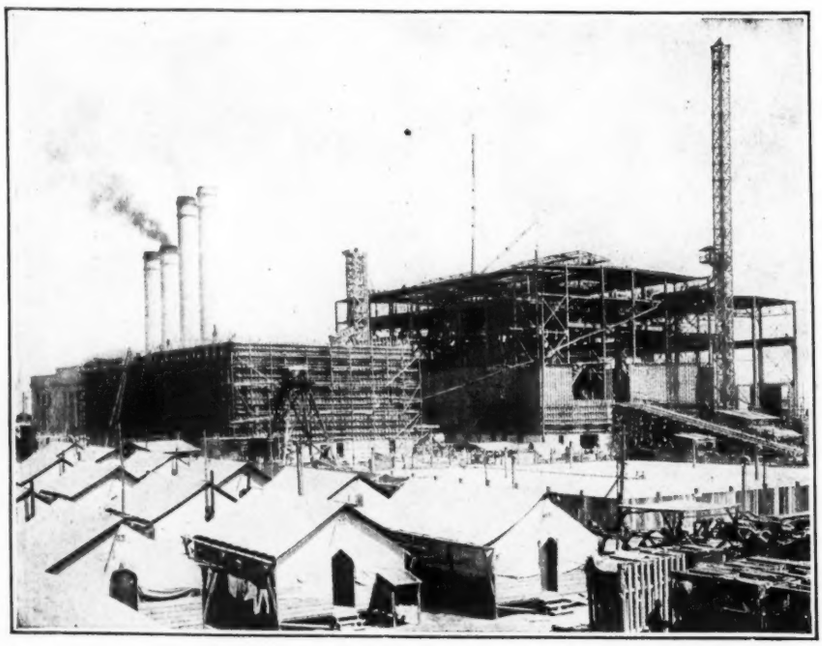
Orienta Falls Plant To Be Enlarged

The Northern Wisconsin Hydro-Electric Power Co. announces that it will double the capacity of its water-power plant at Orienta Falls next year. The company has just expended $160,000 in additions and improvements and has constructed 60 miles of 22,000-volt transmission lines interconnecting Bayfield, Cornucopia, Herbster, Port Wing and Iron River.

Chicago Mechanical Engineers Entertain

On the evening of Sept. 24 at the City Club, the Chicago Section of the A. S. M. E. held its first meeting of the season. As has become the custom, the program was principally of an entertaining character, in which features designed to draw the attendance into intimate contact were introduced.

To begin with, there was a buffet supper, an orchestra, community singing of songs specially prepared for the occasion, a guessing contest, with prizes, on the dimensions of a metal plate and rod and the number of beans in a container, a spelling contest between the older and the younger members, in which it had been prearranged that the former should win handily, a sleight-of-hand performer and, as a concluding feature, one-half hour of humerous movie reels. The serious business of the meeting consisted of a discussion of the program for the season with suggestions as to the subjects and the method of presentation. The attendance approximated 140. An enjoyable evening was the consensus of opinion. It was apparent that the real purpose of the meeting to make and renew acquaintances and to inspire enthusiasm in the season's work had been effected.



Long Beach 100,000-kw. steam plant being rushed to completion

White Water Creek Plant Started

After efforts extending over two years, the White Water Power Co.'s dam and power plant at White Water Creek, 5 miles from Montezuma, Ga., have been completed, and on Oct. 1 the plant began to furnish light and power to Montezuma, Oglethorpe, Marshallville, Reynolds and other places in the vicinity. The creek is swift and turbulent and on several occasions its waters had broken through the partly completed dam and plant, sweeping everything before them. It is the largest hydro-electric project in Macon County.

New York Should Store 12.5 per Cent of Coal Consumed

To prevent shortage, the coal consumers of New York should store 12.5 per cent of the city's annual coal consumption, it was stated in a report of the Coal Storage Committee of the American Engineering Council recently made public. The estimate includes both seasonal and reserved storage. Greater use of available storage space and a change in the storage periods are urged.

For New York and other industrial centers the committee recommends uniform monthly shipment plans, set up as a standard in view of the difficulty of bringing about what is called the ideal practice of storing during the summer a large portion of the amount consumed during the winter.

The engineers take as a basis for calculation for the monthly shipment plan, seventeen of the largest consumers, the principal public utilities, regarded as typical consumers: Monthly shipments of 291,075 tons to the seventeen consumers; seasonal storage of 184,150 tons; seasonal storage equal to 5.2 per cent of the annual consumption; reserve storage of 7.3 per cent of annual consumption; total storage of 12.5 per cent of annual consumption.

"New York City and its vicinity," the report states, "have available for storing coal large areas in New Jersey, Staten Island, Long Island and some very small islands in the metropolitan district.

"The seventeen consumers' total consumption for the year 1922-23 was 3,492,900 tons. A storage of 116,100 tons during the winter was revealed. The change necessary for instituting equal monthly shipments would mean changing the storage period and utilizing fully the storage space available.

"The total consumption for New York is not known, and notwithstanding the seventeen firms reporting are large users of coal a specific deduction is not justified. However, the consumers of New York should certainly store, including both seasonal and reserve storage, 12.5 per cent."

Conditions in New York State are dealt with in a section of the report, which, when completed, will comprise about 100,000 words and be made public following a meeting of the Administrative Board of the American Engineering Council to be held in Chicago Oct. 17 and 18.

Personal Mention

W. C. Brown has again become connected with the Stumpf Uniflow Engine Co., of Syracuse, N. Y., as managing director.

Col. William Kelly, chief engineer of the Federal Power Commission, will spend the month of October on an inspection tour of water-power projects in the west.

Wolfgang Turnwald has left the Stumpf Uniflow Engine Co., Syracuse, N. Y., to become chief engineer of the Chuse Engine & Manufacturing Co., of Mattoon, Ill.

H. V. Coes, formerly industrial engineer for Ford, Bacon & Davis, Philadelphia, Pa., has recently joined the Belden Manufacturing Co., maker of insulated, enamel and magnet wire, etc., Chicago, Ill., as vice-president and general manager.

Obituary

Thomas H. Leisk, aged 58 years, formerly plant superintendent of the Cudahy works of the Worthington Pump & Machinery Corp., near Milwaukee, died Sept. 22 at the home of his son in St. Louis, Mo. Illness compelled him to retire from active affairs about five years ago.

Society Affairs

The Connecticut State Association of the N.A.S.E. will hold its regular meeting at New Haven on Oct. 11.

The Hartford Section of the A.S.M.E. will hear Hiram P. Maxim, of the Maxim Silencer Co., speak on "Silencing Large Suctions and Exhausts," at its Oct. 13 meeting.

The Vancouver, Wash., Section of the A. I. E. E. will have as the attraction for its Nov. 8, meeting an inspection trip to Ballantyne Pier and the Government Elevator, with a talk by W. G. Swan.

The Affiliated Engineers Society of Boston will hold a large dinner in the new Chamber of Commerce Building on Oct. 23. All the member sections will participate. There will be two speakers.

The Hartford Chapter of the American Society for Steel Treating will, at its Oct. 7 meeting, hear General Dickson and Dr. F. C. Langenberg, of the Watertown Arsenal, speak on the subject of X-ray examination of steel and the impact resistance of heat-treated steels at elevated temperatures.

The A.S.C.E. will hold its fall meeting at Detroit, Mich., with headquarters at the Hotel Tuller, Oct. 23-25. One topic for discussion will be "The St. Lawrence Deep Waterway to the Sea." The Power Division will discuss the problem of ice at hydro plants. There will be excursions to near-by plants including the Ford River Rouge and Highland Park Assembling plants, and the Detroit Edison Co.'s power plants.

The Newcomen Society, 28 Victoria St., London S.W. 1, will hold its first ordinary meeting of the season on Oct. 8 at the Rooms of the Iron and Steel Institute when three papers will be presented: "A Sketch of the Industrial History of the Coalbrookdale District," Rhys Jenkins; "The Discoveries of the Darbys of Coalbrookdale," by T. S. Ashton; "Notes on Coalbrookdale and the Darbys," by John W. Hall.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution Washington, D. C. Meeting at Washington Dec. 29-Jan. 3, 1925.

American Electric Railway Association. James W. Welsh, 8 West 40th St., New York City. Meeting at Atlantic City, Oct. 6-10.

American Institute of Chemical Engineers. Dr. John C. Olsen, Polytechnic Institute, Brooklyn, N. Y. Annual meeting at Hotel Schenley, Pittsburgh, Pa., Dec. 3-6.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Fall convention at Pasadena, Calif., Oct. 13-17.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Autumn meeting at Birmingham, Ala., Oct. 13-15.

American Society of Civil Engineers. 29 West 39th St., New York City. Fall meeting at Hotel Fuller, Detroit. Oct. 23-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 1-4.

American Society of Refrigerating Engineers. W. H. Ross, 35 Warren St., New York City. Annual meeting at New York City, Dec. 1-3.

American Welding Society. Miss M. M. Kelly, 29 West 39th St., New York City. Convention in Cleveland, Hotel Winton, Oct. 30-31.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Eighteenth annual meeting at Hotel Chelsea, Atlantic City, N. J., Nov. 12-14.

Electrical Exposition. Lincoln Bancroft, 124 West 42nd St., New York City. Exposition will be held at the Grand Central Palace, New York City, Oct. 15-25.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Greenbriar, White Sulphur Springs, W. Va., Oct. 20-23.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Que. Annual meeting at Montreal, Que., Jan. 27-29.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Briarcliff Lodge, Briarcliff Manor, N. Y., Oct. 27-31.

National Association of Practical Refrigerating Engineers. E. H. Fox, 5707 West Lake St., Chicago, Ill. Convention at New Orleans, La., Nov. 11-14. Exhibits at the Isaac Delgado High School.

National Exposition of Power and Mechanical Engineering. C. F. Roth, Grand Central Palace, New York City. Annual exposition at New York City, Grand Central Palace, Dec. 1-6.

Society of Automotive Engineers. C. F. Clarkson, 29 West 39 St., New York City. Annual meeting at Detroit, Mich., Jan. 20-23.

Society of Naval Architects and Marine Engineers. Daniel H. Cox, 29 West 39th St., New York City. Annual meeting at 29 West 39th St., New York City, Nov. 13-14.

Trade Catalogs

Fans, Exhaust—Diehl Manufacturing Co., Elizabeth, N. J. Bulletin No. 1650 gives tables, drawings, photos and descriptions of these motor-driven exhaust fans, for direct current and alternating current. This bulletin may be obtained by writing for a copy.

Turbine Generators—Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. A new publication, known as Circular 1704, "Westinghouse Turbine Generators," has recently been issued by the company. It describes and illustrates turbines from 500 to 6,000 kw. and traces the early history and progress of the steam turbine from the first installation made by George Westinghouse in 1899 in the air brake plant at Wilmerding to the present day. Features of more recent design are discussed such as the solid steel rotor and the lubrication system and a discussion of bleeder turbines, mixed-pressure turbines and details of generators is also included.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Sept. 22, 1924	Sept. 29, 1924
Pool 1	New York	$3.00	$3.00
Smokeless	Columbus	2.25	2.25
Clearfield	Boston	2.35	2.35
Somerset	Boston	2.40	2.50
Kanawha	Columbus	1.55	1.55
Hocking	Columbus	1.65	1.75
Pittsburgh No. 8	Cleveland	1.90	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.80	1.80
S. E. Ky.	Louisville	1.75	1.75
Big Seam	Birmingham	1.75	1.75

FUEL OIL

New York—Oct. 2, light oil, tank-car lots; 28@34 deg. Baumé, 4¾c. per gal.; 36@40 deg. 5c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Sept. 23, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.75 per bbl.; 26@28 deg., $1.80 per bbl.; 28@30 deg., $1.85 per bbl.; 30@32 deg., $1.90 per bbl.; 32@36 deg., gas oil, 5.5c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Sept. 25, f.o.b. local refinery; 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., fuel oil, 5¼c. per gal.

Dallas—Sept. 30, f.o.b. local refinery, 26@30 deg., $1.15 per bbl.

Philadelphia—Sept. 25, 28@30 deg., $1.99½@$2.06 per bbl.; 18@22 deg., $1.87½@$1.93¾; 13@16 deg., $1.75@$1.81½ per bbl.

Boston—Sept. 29, tank-car lots, f.o.b.; heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5¼c. per gal.

Cincinnati—Sept. 29, tank-car lots f.o.b. local refinery, 24@26 deg., Baumé, 5c. per gal.; 26@30 deg., 5¼c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Sept. 29, 20@22 deg., 5½c. per gal.; 24@26 deg., 6c. per gal.; 28@30 deg., 6c. per gal.

New Plant Construction

Ala., Birmingham—The Alabama Power Co. will erect a 12 story office building on the northwest corner of Sixth Ave. and 18th St., N., estimated cost $1,000,000.

Ala., Florence—P. F. Samuels, ch. of Supply Div., U. S. Engr. Office, will receive bids until Oct. 15 for 3 electric elevators for power house at Wilson Dam, estimated cost $25,000. Col. G. R. Spalding, is engineer.

Calif., Hollywood—C. E. Toberman, 1761 North Harvard St., Los Angeles, is having plans prepared for the construction of a theatre on Hollywood Blvd., between Orchard and Orange Sts., estimated cost $1,500,000. Meyer & Holler, architects and engineers.

Calif., Los Angeles—C. Danziger & Associates, Security Bldg., awarded the contract for the construction of a 12 story hotel on Vine St. Walker & Eisen, 701 Great Republic Life Bldg., are architects.

Calif., Oakland—Consumers Ice Co., 436 8th St., San Francisco, plans the construction of an ice plant on Cotton and Livingston Sts., estimated cost $75,000.

Conn., Hartford—T. C Hardie, 72 Russ St., is having plans prepared for the construction of a 250 room hotel at Asylum and High Sts., estimated cost $2,500,000. Architect not selected.

Conn., New London — Pequot Steam Laundry, Inc., 71 Pequot Ave., plans to rebuild laundry recently destroyed by fire, estimated cost $50,000. Engineer not selected.

D. C., Washington—Office of Lt. Col. C. C. Sherrill, U. S. Army Supt. Buildings and Grounds, 1036 Navy Bldg., 18th and B Sts., N. W., will receive bids until Oct. 9, for boiler plant improvements, consisting of boiler steam lining, steel concrete asbestos covered metal, concrete footings, base course, tunnel and stock found, pit trenches, fuel oil tanks, founds and supports for boiler, etc., structural steel framing, steel and iron work, steel sash, tubular steel doors, asbestos covered, metal roofing and siding, ventilators and two 20,000 gal. reinforced concrete tanks, etc.

Fla., Punta Gorda—The City, J. Jordan, Mayor, will receive bids until Oct. 16 for the construction of a sewage system, including two 250 g.p.m. sewage pumps, 2 pumping stations, tanks, etc., estimated cost $100,000; also water-works system, consisting of pumping station, 270,000 gal. reservoir, one 750 g.p.m. and one 250 g.p.m. electric motor pumps, estimated cost $100,000. J. B. McCrary Engineering Corp., Citizens & Southern Bank Bldg., Atlanta, Ga., is engineer.

Ill., Edwardsville—Long Lake Drainage & Levee Sub-Dist. Chouesau, Dameoka & Venice Drainage & Levee Dist., c/o H. Krauskopf, Chn., awarded the contract for main ditch, laterals, outlet ditch, pumps, etc. Sheppard & Morgan, Bank of Edwardsville Bldg., engineers.

Ill., Jonesboro—The City will take bids about Nov. 1 for water-works system, including pumping equipment, tank on tower, etc., estimated cost $42,000. W. A. Fuller Co., 1917 Railway Exchange, St. Louis, Mo., is engineer.

Ind., Fort Wayne — Northern Indiana Gas & Electric Co. plans the construction of 2 gas holders, a by-product building, screening station, quenching station, generator house, boiler house, etc., estimated cost $350,000.

Mass., Cambridge—Acme Apparatus Co., 37 Osbourne St., awarded the contract for the construction of a boiler house, and enameling building on Osbourne St., estimated cost $40,000.

Mass., Worcester—Cudahy Packing Co., Foster St., is having plans prepared for the construction of a 2 story cold storage plant on Franklin St. Private plans.

Mich., Detroit—Board of Education, 1354 Broadway Ave., will soon award the contract for the construction of a 2 story, 59 x 65 ft.power house on LaSalle Blvd. and Tuxedo Ave. Boilers, pumps, motors, etc., will be required. McColl, Snyder & McLean, 2348 Penobscot Bldg., engineers.

Mich., Saginaw—Second National Bank, 110 North Washington St., awarded the contract for the construction of a 12 story bank and office building. Smith, Hinchman & Grylls, 800 Marquette Bldg., Detroit, are architects.

Mo., Bloomfield—The City plans a complete waterworks system, including tank on tower, pumps, hydrants, valves, distribution mains, etc., also system of sanitary and storm sewers, estimated cost $75,000. J. P. Davis, Central Trust Bldg., Jefferson City, engineer.

Mo., Kansas City — Medical Art Bldg., c/o G. B. Post & Son, architects, 101 Park Ave., New York, is having plans prepared for the construction of an office building. Cost will exceed $750,000.

Mo., St. Louis—Board of Public Service, 208 City Hall, will receive bids until Oct. 28 for a heating and ventilating system for Union Market, estimated cost $46,000. L. R. Bowen, 301 City Hall, architect and engineer.

Mo., St. Louis — Community Power & Light Co., 408 Pine St., plans the construction of a power plant on west bank of the Mississippi River in Cape Girardeau district for Missouri Public Utilities Co., estimated cost $2,000,000.

Mo., St. Louis—Local Syndicate, c/o G. Sokol, architect, 7069 Pershing Ave., is having plans prepared for the construction of a 10-story commercial building on Washington and 13th St., estimated cost $1,000,000.

Neb., Lincoln — T. H. Berg, City Clk., will receive bids until Oct. 10 for two 500 hp. water tube boilers, 2 chain grate stokers, 1 economizer, 2 superheaters, and 2 soot blowers. D. L. Erickson, City Hall, engineer.

N. Y., Brockport—Board of Water Commissioners will receive bids until Oct. 13th, for improvements to the pumping station. B. A. Thompson, clerk.

N. Y., Buffalo — G. Ziff, 42 Clarendon Pl., plans the construction of a 6 story apartment house, estimated cost $2,000,000.

N. Y., New York—Masonic Club Bldg., Inc., 135 Broadway, R. L. Bernier in charge, awarded the contract for the construction of a 24 story hotel and club at 130 West 49th St., estimated cost $2,000,000.

N. Y., New York—New York Edison Co., Irving Pl., having plans prepared for the construction of a power house at 801-827 East 14th St., estimated cost $3,500,000. T. E. Murray, Inc., 55 Duane St., is architect.

O., Youngstown — First National Bank, awarded the contract for the construction of a 12 story bank and office building, estimated cost $1,500,000.

Okla., Marland — The City is having plans prepared for a new waterworks system, including well, pipe line, deep well pump, mains, elevated tank, hydrants, etc., estimated cost $20,000. Engineer not selected.

Okla., Webb City—The City is having plans prepared for a new waterworks system, including a deep well, pump, elevated tank, tower, mains, pipe lines, valves, hydrants, etc., estimated cost $25,000. Engineer not selected.

Okla., Wetumka — The City is having plans prepared for a new water purification plant, new pumps, oil engine generator plant, mains, valves, hydrants, and extensions to the electric distribution system, estimated cost $115,000. V. V. Long & Co., engineers. Bonds will be voted Oct. 28.

Okla., Wewoka—The City voted $150,000 bond issue for improvements to waterworks system, including marine engine unit, etc. V. V. Long & Co., Oklahoma City, is engineer.

Ore., Portland — The City Commission plans the construction of a high pressure water system, including pumps, hydrants, etc., estimated cost $1,426,000. A. L. Laurgaard, city engineer, E. C. Willard, Corbett Bldg., is consulting engineer.

Pa., Bellefonte—Bellefonte Hospital, H. S. Moore, Chn. Bldg. Com., will receive bids until Oct. 29 for the construction of a pavilion and power plant on High St., estimated cost $150,000.

Pa., Morganza — Pennsylvania Training School, W. F. Penn, Supt., is having plans prepared for the construction of a 1 story laundry building, estimated cost $150,000. F. McCrooks, 541 Third Ave., Pittsburgh, is architect.

Pa., Shippingport — The Duquesne Light Co., Pittsburgh, awarded the contract for the construction of a power plant, estimated to cost $23,000,000.

R. I., Providence—What Cheer Laundry Co., Cranston and Burgess Sts., awarded contract for a 2 story addition to laundry, estimated cost $40,000.

Tex., Dallas — The City, M. G. James, Secy., City Hall, will receive bids until Oct. 24 for a 23,000,000 gal. centrifugal pump, to be installed at Cadiz St. pumping station. E. A. Kingsley, City Hall, is engineer.

Tex., Dallas—Mid-West Engineering Co., Slaughter Bldg., will soon receive bids for the construction of a 7 story apartment house on Maple Ave., estimated cost $700,000.

Tex., Denton—College of Industrial Arts, E. V. White, Dean, plans the construction of a group of college buildings, including a refrigerating plant, estimated cost $200,000.

Tex., Greenville—J. O. Williams, Secy., City Hall, will receive bids until Oct. 14, for a 1,250 kw. turbine generator, 3,600 r.p.m., 3 phase, 60 cycle, 2,300 volt with exciter, switchboard and condenser.

Wis., Berlin—Fuhremann Canning Co., J. Fuhremann, Pres., plans to construct a cannery, including a 1 story boiler house. An 80 hp. boiler and steam engine will be installed. Estimated cost $85,000. Private plans.

Wis., Milwaukee—J. H. Lambrecht, 2601 North Ave., awarded the contract for the construction of a dairy on 30th St. and will be in the market for refrigeration machinery, estimated cost $60,000. Herbst & Kuenzli, 130 Grand Ave., are architects.

Wis., Portage — Portage Co-operative Creamery Co. will soon receive bids for the construction of a 2 story creamery, estimated cost $40,000. Kampfer & Buetow, 1380 Blair St., St. Paul, Minn., architects.

Ont., Acton—The City Council plans to install an auxiliary pump (gasoline driven), also extend water mains, etc., estimated cost $25,000. J. Proctor & Redfern, 17 Toronto St., Toronto, are engineers.

Ont., Chippawa—The City awarded the contract for a waterworks system, including pumps, etc., estimated cost $120,000.

Ont., Riverside — The City is having plans prepared for sewage disposal plant, activated sludge type, including air compressor and motor, estimated cost $35,000. A. Smith is engineer.

Ont., Thetford — Consolidated Asbestos Mines, G. L. Treglown, Purch. Agt., plans to purchase 1 electric motor, 2 pumps, 1 set of batteries.

Ont., Toronto—The City, W. W. Hietz, Mayor, City Hall, will receive bids until November 11 for a 10 million imperial gallon, steam turbine driven centrifugal pump. R. C. Harris, City Hall, is engineer.